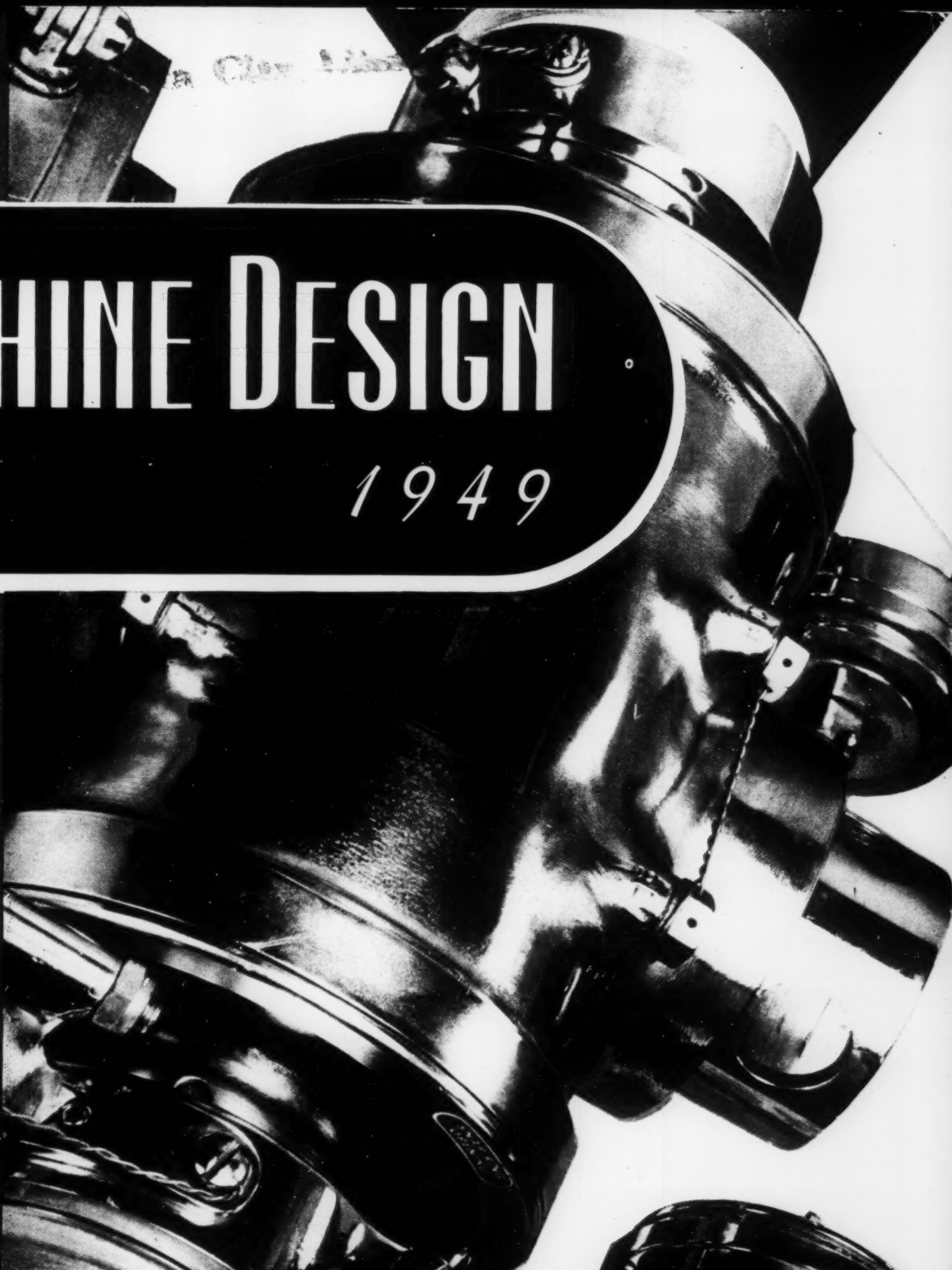
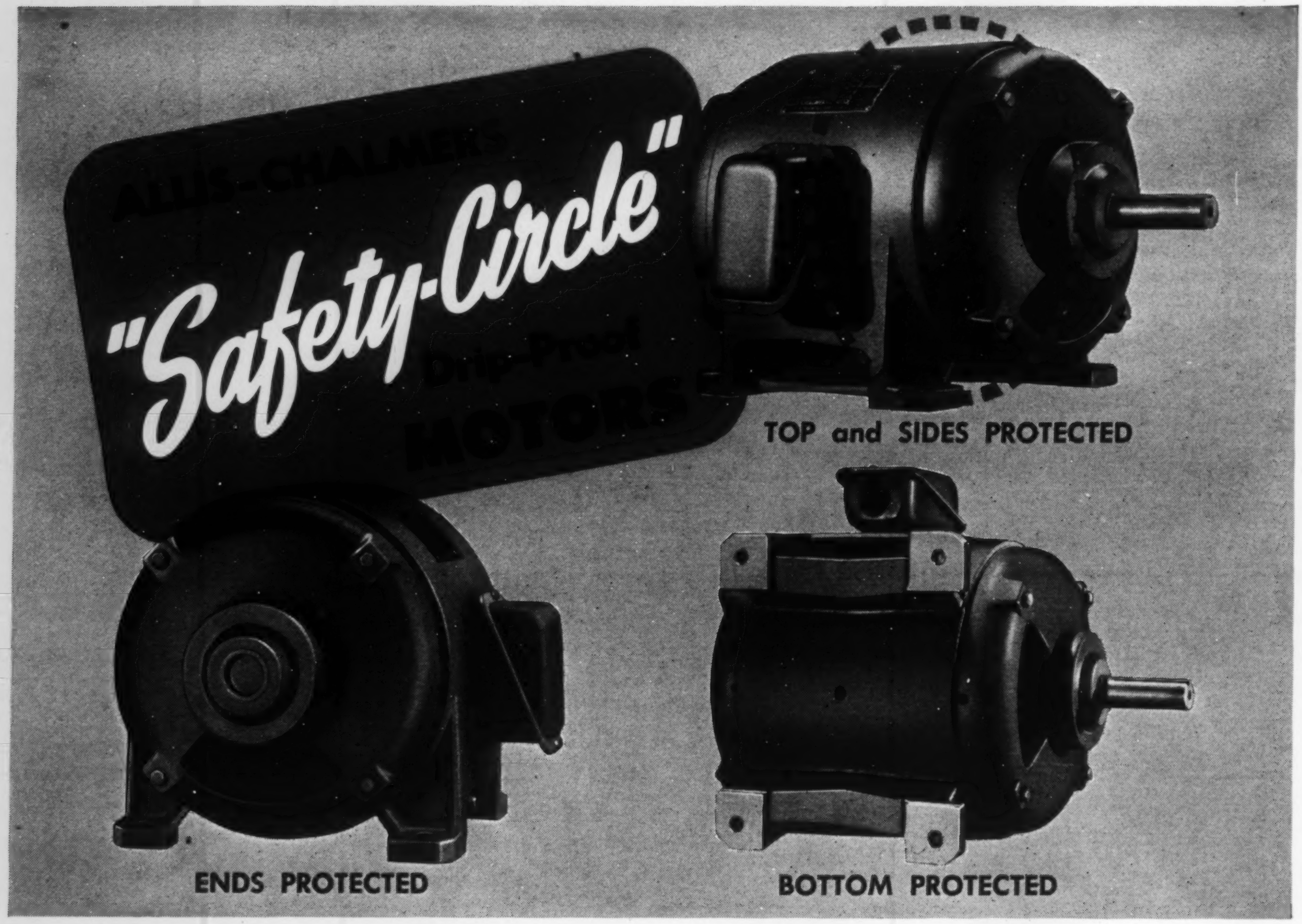
MACHINE DESIGN

May 1949



In This Issue: **MAGNETIC FLUID CLUTCH . . . DESIGNING CAMS**
BALL BEARINGS . . . STRESSES IN DISKS . . . ELECTRONIC COUNTERS



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SAFETY-CIRCLE

THAT SOLID CAST IRON FRAME protects SAFETY-CIRCLE working parts against physical damage from every angle. The completely enclosed bottom provides extra protection and extra strength. End brackets are drip-proof at no premium.

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SAFETY-CIRCLE protects against internal breakdown with multiple-dipped and baked stator and die-cast aluminum rotor. *Ball bearings are factory-lubricated and need no attention for years.* Wide open internal construction and large fans keep temperatures well within rated limits.

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For complete details on SAFETY-CIRCLE advantages, see your A-C Authorized Dealer, Sales Office, or write for Bulletin 51B6210B. Sizes from 1 to 20 hp, 326 frames and smaller. Safety-Circle, Texrope and Vari-Pitch are Allis-Chalmers trademarks.

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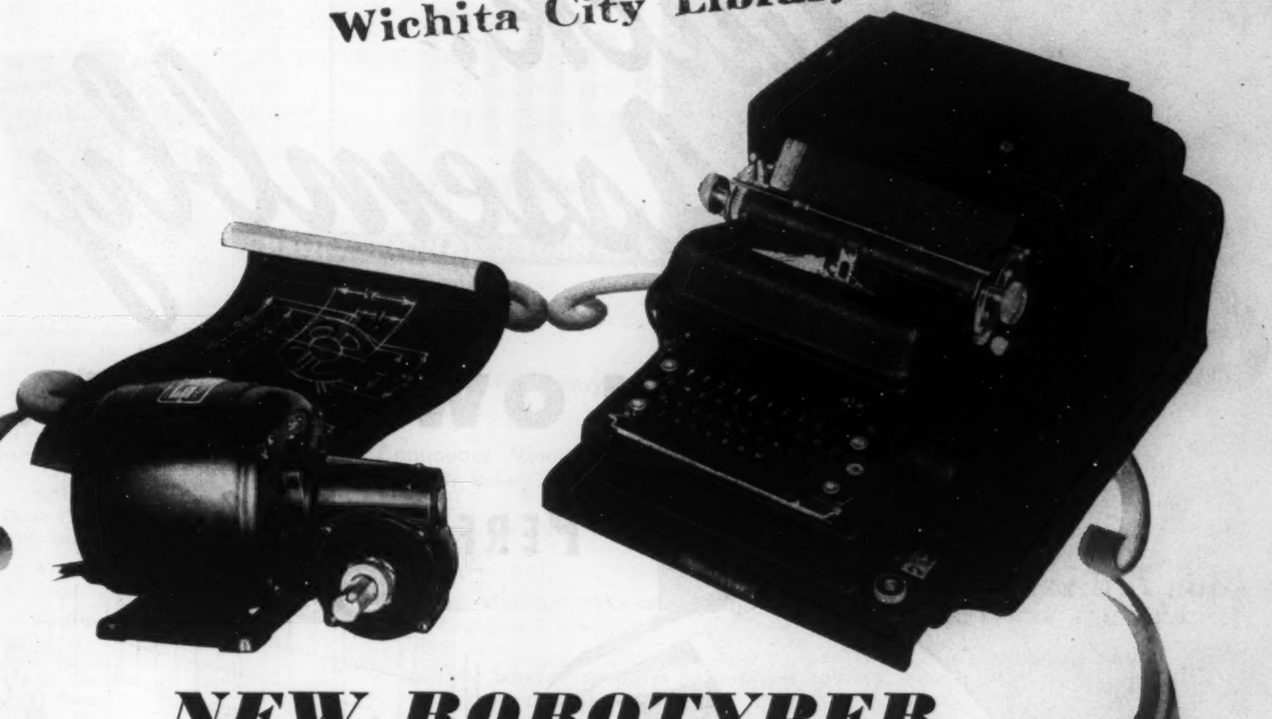

NEW ROBOTYPER
uses a
Bodine Motor

DESIGNED to produce letters automatically . . . the Robotyper operates as an attachment to any electric typewriter. With a Robotyper, individually typed letters, identical except for address and salutation, can be typed to a long list of people . . . quickly and inexpensively.

It is easy to operate. A letterhead is inserted in the Robotyper, and the address and salutation are inserted by a typist. She then touches a button . . . and the remainder of the letter is automatically typed by a perforated master roll through pneumatic controls.

A 1/15 hp Bodine speed reducer motor drives the bellows pump and master roll of the Robotyper. The Bodine motor was selected because it provided the required power in a compact unit, and its design was in keeping with the precise workmanship and dependability of the Robotyper. Bodine has over 3000 standard specifications to choose from.

Over 40 years' experience in applying motors to all kinds of applications has given Bodine engineers a background of experience that can be helpful to you. The Bodine line includes precision-built fractional horsepower motors and speed reducer motors—from 1/2000 to 1/6 hp, in all types of windings and frames.

Bodine motors, in most of the popular specifications, can be supplied from stock. Others can be produced in 6 to 12 weeks—test motors, 3 to 8 weeks. Bodine Electric Company, 2258 West Ohio Street, Chicago 12, Illinois.

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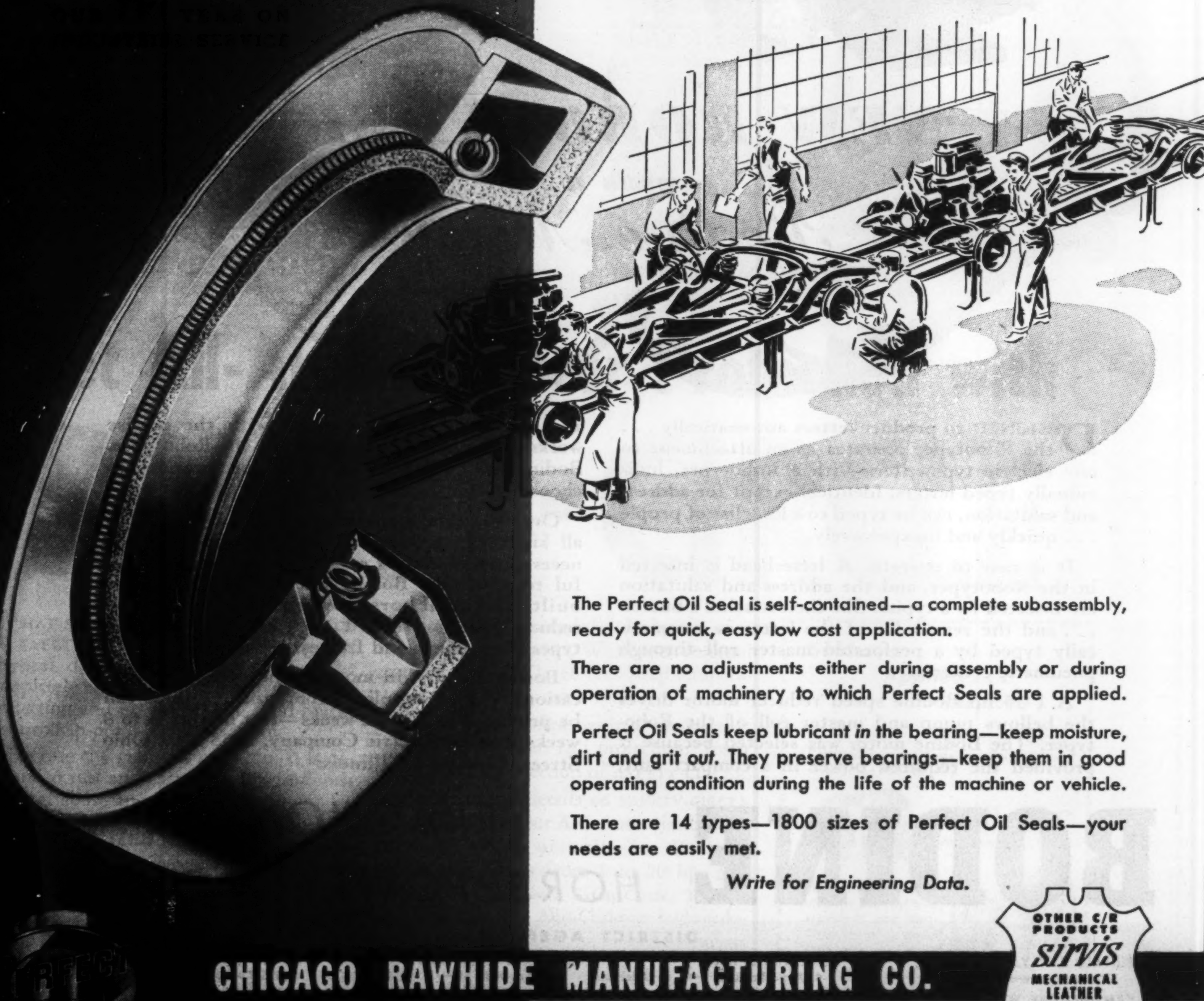

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MACHINE DESIGN

Vol. 21—No. 5 May, 1949

THE PROFESSIONAL JOURNAL OF CHIEF ENGINEERS AND DESIGNERS

This Month's Cover: Automatic variable-pitch propeller designed by Aeromatic Propeller department of Koppers Co. Centrifugal weights maintain proper pitch for controlling engine speed. When desired, a manual control allows pilot to adjust pitch.

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Published by The Penton Publishing Co. E. L. SHANER, Chairman of the Board and Treasurer; G. O. HAYS, President; R. C. JAENKE, Vice President; F. G. STEINEBACH, Vice President and Secretary; E. L. WERNER, Assistant Treasurer.

Published on the seventh of each month. Subscription in the United States and possessions, Canada, Cuba, Mexico, Central and South America: One year $10. Single copies, $1.00. Other countries one year, $15.

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Acceptance under Act of June 5, 1934. Authorized July 20, 1934.

CONTENTS

Designing for Today's Needs (Editorial) 87

Continuous Miner 88
By Richard K. Lotz

Scanning the Field for Ideas 95

Clutches—characteristics and design of magnetic fluid types 98
By Robert S. Elberty

Pneumatic Sander—employs magnesium housing, steel working parts ... 103
By C. N. Douglass

Key Factors in Cam Design and Application—Part II 107
By John A. Hrones

Controlling Machines with Electronic Counters 112
By Earl B. Hitchcock

Model Research Airport 118

Production Processes—Part XLIII—Welding, General Considerations 119
By Roger W. Bolz

The Engineering Graduate in Machine Design 126
By C. H. Young

Superprecision Ball Bearings—Part VI—Lubrication and Systems 127
By Thomas E. Rounds

Dollars-and-Cents Advantages of Powder Metal Parts 133
By Joseph L. Bonanno

Centrifugal Stresses in Disks—simplified analysis 137
By Frank Beck

Helical Gears to Replace Spur Gears (Data Sheet) 149
By Carl A. Johnson

DEPARTMENTS

Itemized Index 7
Topics 84
Designs of the Month 144
New Parts and Materials 154
Eng. Dept. Equipment 166
Helpful Literature 167
Men of Machines 170
Assets to a Bookcase 174
Noteworthy Patents 176
Sales Personnel 186
Sales Notes 190
Meetings and Expositions 194
Design Abstracts 196
New Machines 208

DESIGNING FOR PRODUCTION AND SALES • STYLING
MATERIALS SPECIFICATION • DESIGN ANALYSIS
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Worrying about *VIBRATION FATIGUE?*

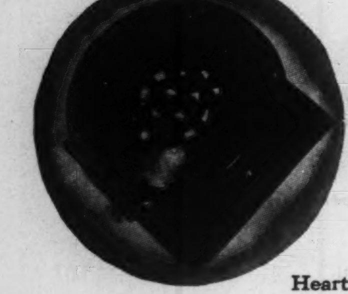
Read how these 5 metal-selection problems were solved

VIBRATION FATIGUE... notorious destroyer of springs and working parts... is doubly difficult to defeat when the design picture is complicated by corrosion, extreme heat or cold.

Many manufacturers have found a time-tested solution to this problem in the family of INCO Nickel Alloys. These "task metals" put at your command a unique combination of physical properties... high strength, excellent corrosion resistance, good thermal endurance, and outstanding resistance to vibration fatigue.

Perhaps one of the five examples shown will suggest a solution to your own problems. If not, our Technical Service Department will gladly make recommendations based on years of metal research and a vast fund of practical experience data.

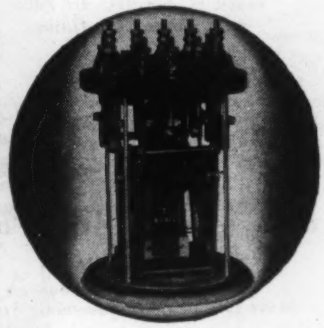
Write for your free copy of the helpful new booklet: *"66 Practical Ideas for Metal Problems in Electrical Products."*



SIGNAL HORN

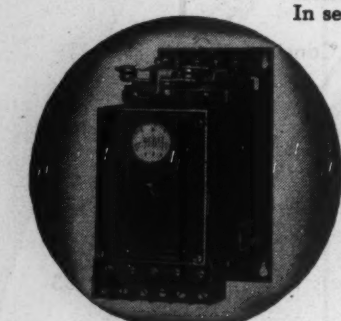
Designed for use in factories where moisture and corrosives might be present, the diaphragm of this horn had to be corrosion-resistant as well as vibration fatigue-resistant. Edwards & Co., Norwalk, Conn., chose *Inconel** for the job and has received no reports of horn failures even from plants where corrosive fumes are constantly present.

CODE TRANSMITTER



Heart of this instrument is a pendulum-type armature which vibrates continuously at 180 times a minute, 94 million times a year. The transmitter controls code impulses to railway signals and engine cabs, showing traffic on the rails at any moment. To insure dependable operation, the armature must be a good electrical conductor, and have high resistance to fatigue failure.

Union Switch and Signal Company states: "'Z'* Nickel proved to be an ideal metal for armatures because it offers maximum resistance to fatigue. In several years' experience, none has been known to break."

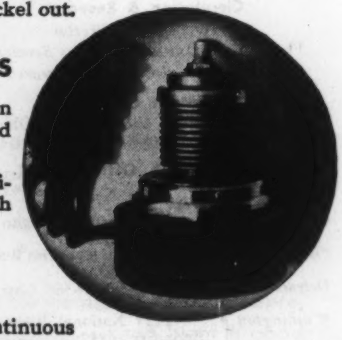


INDUSTRIAL TIMER

This Series "2800" Timer gives split-second control of many industrial operations. A particularly critical part of the design was a shock absorber which cushions the operating impact of a solenoid plunger.

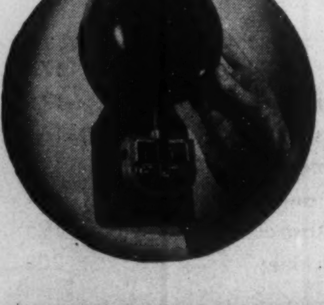
After several fatigue-resisting alloys had failed at the million mark in flexing tests, engineers of the Automatic Temperature Control Co., Inc., standardized on "Z" Nickel for the shock absorber. Tests and field reports show that more than five million blows have failed to knock "Z" Nickel out.

BELLOWS



For operating automatic switches controlling temperature and pressure in refrigerating systems, these bellows had to be both corrosion-resistant and proof against failures caused by constant flexing.

The Fulton Sylphon Co. chose Monel* for this job... and solved a difficult metal problem. The bellows are made from .050" sheet Monel, which is fabricated into a tube .0065" thick.



WARNING BELL

To guarantee emergency performance, and at least 1,000 hours of continuous use, the flat reaction spring of this bell required a metal that was both corrosion and fatigue resistant.

Tests showed that some metals lasted only a few hours. But "Z" Nickel performed perfectly after 2,600 hours of continuous service.

In addition, to prevent corrosion freezing within the bushing, the plunger which strikes the bell is made of Monel.

THE INTERNATIONAL NICKEL COMPANY, INC. • **67 Wall Street, New York 5, N.Y.**

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*Reg. U. S. Pat. Off.

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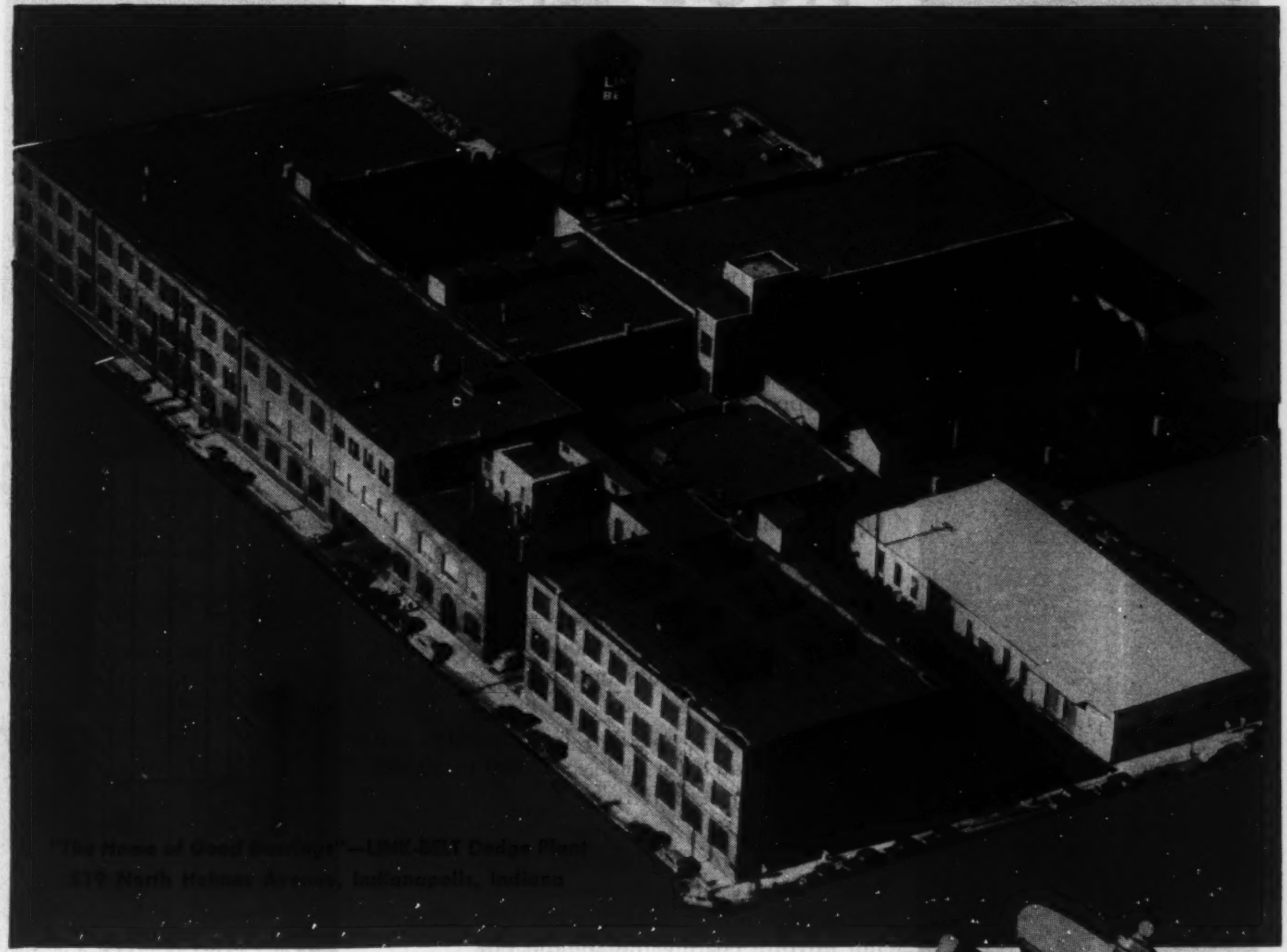

"The Home of Good Bearings"—LINK-BELT Dodge Plant
519 North Holmes Avenue, Indianapolis, Indiana

Meeting industry's ever-increasing demands for ball and roller bearings that offer the desired combination of free-rolling action, self-alignment, and long life is no small-sized job.

That's why the entire capacity of Link-Belt's Dodge Plant in Indianapolis is devoted to this important task.

From the receipt of housing castings furnished by sister plant foundries to shipment of finished mounted bearings, alert design engineers, skilled craftsmen and the most modern bearing production machinery work hand-in-hand to turn out the bearings that enable users to TURN SHAFTS EFFICIENTLY.

Cut-away view
of Series 200
Ball Bearing
Pillow Block

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LINK-BELT *Ball and Roller BEARINGS*

AT LAST A MODERN SPINDLE

Designed throughout to promote the most *modern* conditions, the Saco-Lowell New Era Spindle, with New Departure precision ball bearings developed specifically for the purpose, offers a most impressive list of operating advantages.

Spindle blade is stationary and the yarn carrier, supported on two New Departure ball bearings, is the only revolving member.

Power requirements reduced 25% or more and tape life increased nearly 300%.

Under normal conditions, adjusting, repair or replacement of parts is never required. New Departure ball bearings show no perceptible wear after 30,000 hours' operation.

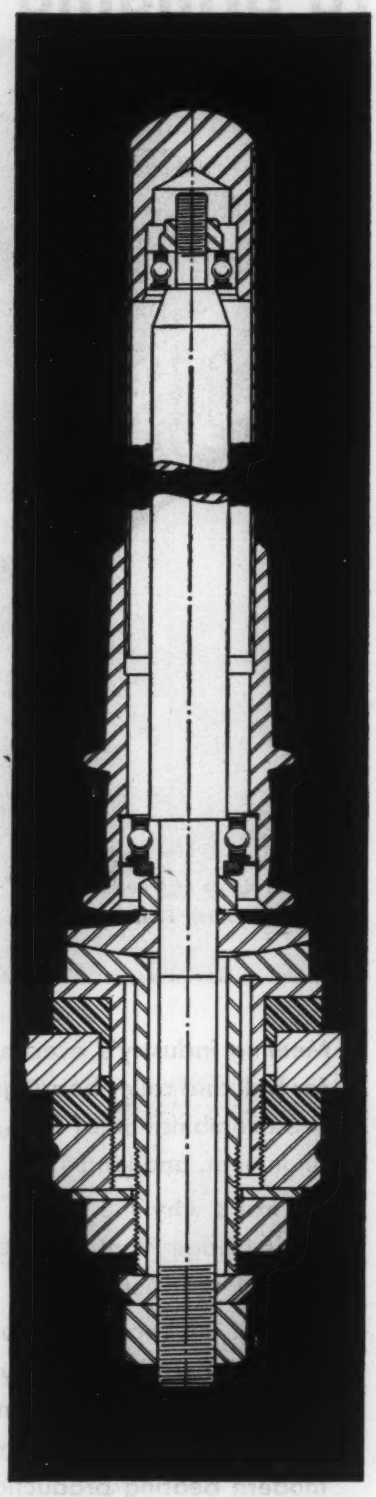
No oil used. Self-enclosed ball bearings are grease lubricated for at least 18,000 to 30,000 hours on a three-shift basis.

New Departure ball bearings provide ample load capacity at high speeds—with no oil throwing—no oil soaked yarn—no oil and lint mixture coating the spindle rail.

Spindle design saves hours of work installing and maintaining accuracy of spindle adjustment.

Performance proved by over five years mill operation and 750,000 spindles before released in unrestricted quantities.

Made for new frames or replacement in old, giving the most *modern* ball bearing advantages in both.



Nothing Rolls Like a Ball

66

NEW DEPARTURE

BALL BEARINGS

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Itemized Index

Classified for convenience when studying specific design problems

Design and Calculations
Airport, for model research testing, Edit. 118
Calibration flasher, Edit. 97
Cam design and application, Edit. 107-111, 178
Clutches, magnetic fluid type, characteristics, Edit. 98-102
Continuous miner, Edit. 88-93
Counters, electronic, for machine control, Edit. 112-117
Disks, centrifugal stresses in, Edit. 137-143
Forming tubular sections, Edit. 95
Helical gears—(Data Sheet), Edit. 149-153
Ideas, selling of, Edit. 198-200
Pneumatic sander design, Edit. 103-106
Powder metal parts, Edit. 133-136, 180, 182, 184
Quality control, Edit. 196-206
Superprecision ball bearings, Edit. 127-132
Welding, general considerations, Edit. 119-125

Engineering Department
Equipment, Edit. 166; Adv. 27, 177, 205, 224, 246, 269
Instruments, Edit. 166
Management, Edit. 126, 196-206
Supplies, Adv. 172, 205, 233, 250, 269

Finishes
Film, Adv. 220
Machined, Adv. 201

Materials
Aluminum alloys, Adv. 8
Beryllium, Adv. 210
Bronze, Adv. 28
Carbon graphite, Adv. 44, 45
Chromium alloys, Adv. 65
Clad metals, Adv. 53
Cobalt alloys, Adv. 65
Copper alloys, Adv. 226
Cork and rubber, Adv. 227
Felt, Adv. 209
Fiber, Adv. 178
Fish paper, Adv. 178
Friction materials, Adv. 189
Gray iron, Adv. 68
Heat treating, Adv. 220
Lubricants, Adv. 176
Magnesium alloys, Edit. 103-106
Manganese alloys, Adv. 65
Nickel alloys, Adv. 4, 65, 197
Plastics, Edit. 164; Adv. 29, 32, 80, 163, 178, 198, 239, 251
Plated metals, Adv. 165
Powder metals, Edit. 133-136, 180, 182, 184; Adv. 71
Rubber and synthetics, Edit. 158; Adv. 32, 198
Steel, Edit. 103-106, 228; Adv. 197, 222, 223
Steel, stainless, Edit. 157; Adv. 34, 35, 46, 236, 245
Tape, electrical, Adv. 202
Thermostat metals, Adv. 43
Zinc, Adv. 219

Parts
Aluminum parts, Adv. 8
Balls, Adv. 206, 248
Bearings:
  Ball, Edit. 127-132, 155; Adv. 5, 6, 11, 30, 31, 37, 194, 206, 266
  Needle, Adv. 231
  Roller, Adv. 5, 11, 30, 31, 62, 179, 187, 258
  Sleeve, Adv. 21, 28, 39, 44, 45, 159
Belts, Adv. inside front cover, 36, 50, 51, 180, 235, 242, 271
Blowers, Adv. 78, 204, 254
Brakes, Adv. 185
Bronze parts, Adv. 28
Bushings, Adv. 252
Cams, Edit. 107-111, 178; Adv. 188
Carbon parts, Adv. 44, 45, 247
Carburetors, Edit. 154; Adv. 56
Castings:
  Die, Adv. 86
  Sand, Adv. 215
Chains:
  Roller, Adv. 14, 15, 81, 193
  Silent, Adv. 49
Clutches, Edit. 98-102, 160, 178; Adv. 49, 83, 85, 185, 258, 263
Collars, Adv. 254
Controls (see Electric, etc.)
Conveyors, Edit. 154, 164; Adv. 180
Counters, Edit. 154; Adv. 60
Couplings, Adv. 49, 186
Cylinders, Adv. 9, 52, 75, 191, 212, 265
Electric controls:
  Circuit breakers, Adv. 50, 51
  Contactors, Edit. 156; Adv. 51
  Control assemblies, Adv. 25, 27, 182, 183, 259, back cover
  Electronic, Edit. 112-117; Adv. 173, 183
  Motor brushes, Adv. 247
  Pressure cells, Edit. 164
  Rectifiers, Adv. 59
  Relays, Adv. 175, 182
  Resistors, Adv. 174
  Starters, Adv. 24
  Switches, Edit. 97, 162; Adv. 50, 51, 54, 244, 262
  Terminal strips, Adv. 266
  Thermostats, Adv. 38
  Timers, Edit. 158, 162; Adv. 182
  Transformers, Edit. 162; Adv. 50, 51
  Voltage regulators, Adv. 50, 51
Electric generators, Adv. 40, 41
Electric heating units, Adv. 63
Electric motors, Edit. 157, 158, 160, 162; Adv. inside front cover, 1, 25, 40, 41, 42, 51, 55, 64, 182, 204, 211, 213, 218, 237, 238, 240, 242, 250, 258, 262
Electric motor parts, Adv. 213
Engines, Edit. 156, 157; Adv. 200, 257, 260, 266
Fasteners:
  Inserts, Adv. 254
  Locking, Adv. 33, 221, 257, 263
  Nuts, bolts, screws, Adv. 17, 19, 243, 272
  Rivets, Adv. 77
  Snap type, Adv. 254
Fittings, Adv. 66, 74, 171, 186
Forgings, Adv. 20, 199
Gear blanks, forged, Adv. 20
Gears, Edit. 149-153; Adv. 13, 58, 71, 72, 188, 218, 246, 250, 260
Generators (see Electric generators)
Heating units (see Electric heating units)
Hose (see Tubing)
Hydraulic and pneumatic equipment:
  Boosters, Adv. 254
  Controls, Adv. 82, 212
  Cylinders, Edit. 155; Adv. 9, 52, 75, 191, 212, 265
  Motors, Adv. 9, 75, 82, 254
  Pumps, Edit. 160, 176; Adv. inside front cover, 9, 16, 22, 23, 51, 52, 61, 69, 75, 82, 195, 234, 244, 254, 259
  Rams, Adv. 22, 23
  Systems, Adv. 9, 22, 23, 52, 69, 75, 82
  Timers, Edit. 156
  Valves, Edit. 157; Adv. 9, 22, 23, 52, 69, 75, 82, 191, 196, 203, 208, 230, 246, 248, 262, 267
Joints, Adv. 260
Leather parts, Adv. 161
Lubrication and equipment, Edit. 127-132; Adv. 171, 176, 232
Machined parts, Edit. 146
Magnetos, Adv. 229
Magnets, permanent, Adv. 70
Motors (see Electric motors)
Mountings, rubber, Adv. 257
Plastic parts, Adv. 29, 32, 80, 198
Plugs, Adv. 192
Pneumatic equipment (see Hydraulic and pneumatic)
Powder-metal parts, Edit. 133-136, 180, 182, 184; Adv. 71
Pumps (see also Hydraulic and pneumatic) Adv. inside front cover, 9, 16, 22, 23, 51, 52, 61, 69, 75, 82, 195, 234, 244, 254, 259, 267
Rings, retaining, Edit. 164; Adv. 225
Rubber and synthetic parts, Edit. 155; Adv. 32, 79, 161, 198
Screw machine parts, Adv. 8, 260
Screws, adjusting, Adv. 265
Seals, packings, gaskets, Edit. 162, 176; Adv. 2. 26. 45, 47, 57. 76, 161, 169, 209, 227, 249, 263
Shafts, flexible, Adv. 220
Spacers, rolled, Adv. 21
Speed reducers, Edit. 154; Adv. 67, 190, 252
Spindles, Adv. 217
Springs, Adv. 73, 242
Sprockets, Adv. 81, 244
Stampings, Adv. 10, 252
Torque converters, Adv. 85
Transmissions, variable speed, Edit. 156; Adv. 9, inside back cover
Tubing:
  Assemblies, Edit. 158
  Flexible, Adv. 12, 186, 216, 241, 265
  Metallic, Adv. 12, 197, 216, 226, 228, 236, 241, 265
  Nonmetallic, Adv. 186
Universal joints, Edit. 164; Adv. 259
Valves (see also Hydraulic and pneumatic) Edit. 155; Adv. 9, 22, 23, 52, 69, 74, 75, 82, 191, 196, 203, 208, 230, 246, 248, 263. 267
Weldments and equipment, Edit. 119-125; Adv. 18, 181, 207

Production
Balancing, Adv. 201
Facilities, general, Adv. 48, 54, 57, 58, 181, 201, 234
Forming Edit. 95
Hardening, Adv. 220, 255
Machines, special, Edit. 145; Adv. 48, 54, 57, 58, 201, 234
Measuring, Adv. 25, 72, 184, 248
Testing and equipment, Edit. 144; Adv. 25, 72, 248, 253
Tools and accessories, Edit. 148; Adv. 54, 72, 173

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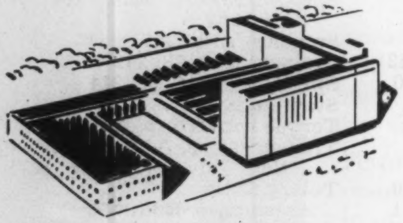

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One of hundreds of applications

Oilgear Fluid Power equipment is used on many different types of machines and processes throughout industry. It is used to drive infinitely delicate process equipment as in photographic film making, printing on cellophane, maintaining the exceedingly thin web in paper-making or dyeing light rayon fabrics.

It is also used where exceptional speed control is needed as in the lumber industry. An Oilgear Sawmill Carriage Drive is small, powerful, and self-contained. It can be coupled to a standard a.c. motor, a diesel or gas engine or mill lineshaft. Its simple, integral control lever gives the sawyer complete command of the sawmill carriage, quick and selective control of carriage speeds, *infinite* speed control in either direction . . . hydro-dynamic braking with regenerative power that's inherent in the system, cushioned and shock-free. There is no possibility of overshoot or runaway.

Second, there's no power plant, no auxiliary equipment, no generator set, no complicated, easy-to-get-out-of-order control mechanism. Nothing can hurt these battleship-built drive units which have proven successful for over a quarter century on other tough drives. Using available alternating current, you convert wood waste to profit instead of fuel, and need no steam engineer.

Third, its operating mechanism is fully enclosed and automatically lubricated. No frequent servicing necessary. Merely change oil every 4 to 8 months.

Oilgear 20 H. P. Two-Way Variable Speed Transmission for Sawmill Carriage Drive.

Oilgear Fluid Power equipment is also used on gang saw feed rolls, set works and holding dogs, edgers, conveyors, veneer lathes, surfacers, hot plate presses and baling presses. In the pulp and paper industry it is used on paper machine drives, calender drives, winder drives, unwinder drives, hold-down systems.

Any machine designer, any manufacturer, can investigate versatile, profitable Oilgear to advantage. THE OILGEAR COMPANY, 1568 W. Pierce St., Milwaukee 4, Wisconsin.

Oilgear Fluid Power

BRANDT IS NOW PRODUCING
AUTOMOTIVE STAMPINGS
FOR ASSEMBLY LINE PRODUCTION

Heavy metal stampings (shown at right) are a typical Brandt job for one of the world's largest automotive manufacturers. Here's precision mass production to meet exacting specifications and rigid delivery schedules.

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Skilled workmanship, ample stockpiles, transportation advantages, complete engineering and production facilities add up to an EXTRA PLANT for you without production headaches.

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From receipt of inquiry all quotations are handled by the Engineering Department and promptly expedited.

PRESSED STEEL SHAPES & STAMPINGS

Brandt is equipped for mass production of pressed steel shapes such as rub rails, posts, roof ribs, channels, stakes, and door panels. Complete or component part stampings for cars, trucks, trailers, busses, and airplanes.

Write for Catalog #400

SEND SAMPLE OR DRAWING FOR QUOTATION

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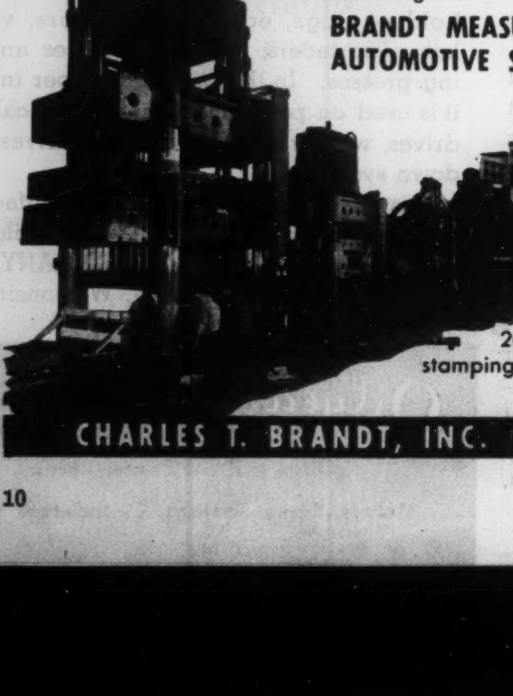
BALTIMORE

when it's gotta fit—

BRANDT MEASURES UP TO EXACTING METAL WORKING SPECIFICATIONS
AUTOMOTIVE STAMPINGS — HEAVY WELDMENTS — PRESSED STEEL SHAPES



200,000 sq. ft. of coordinated stamping, shaping, and welding facilities
—all under one roof

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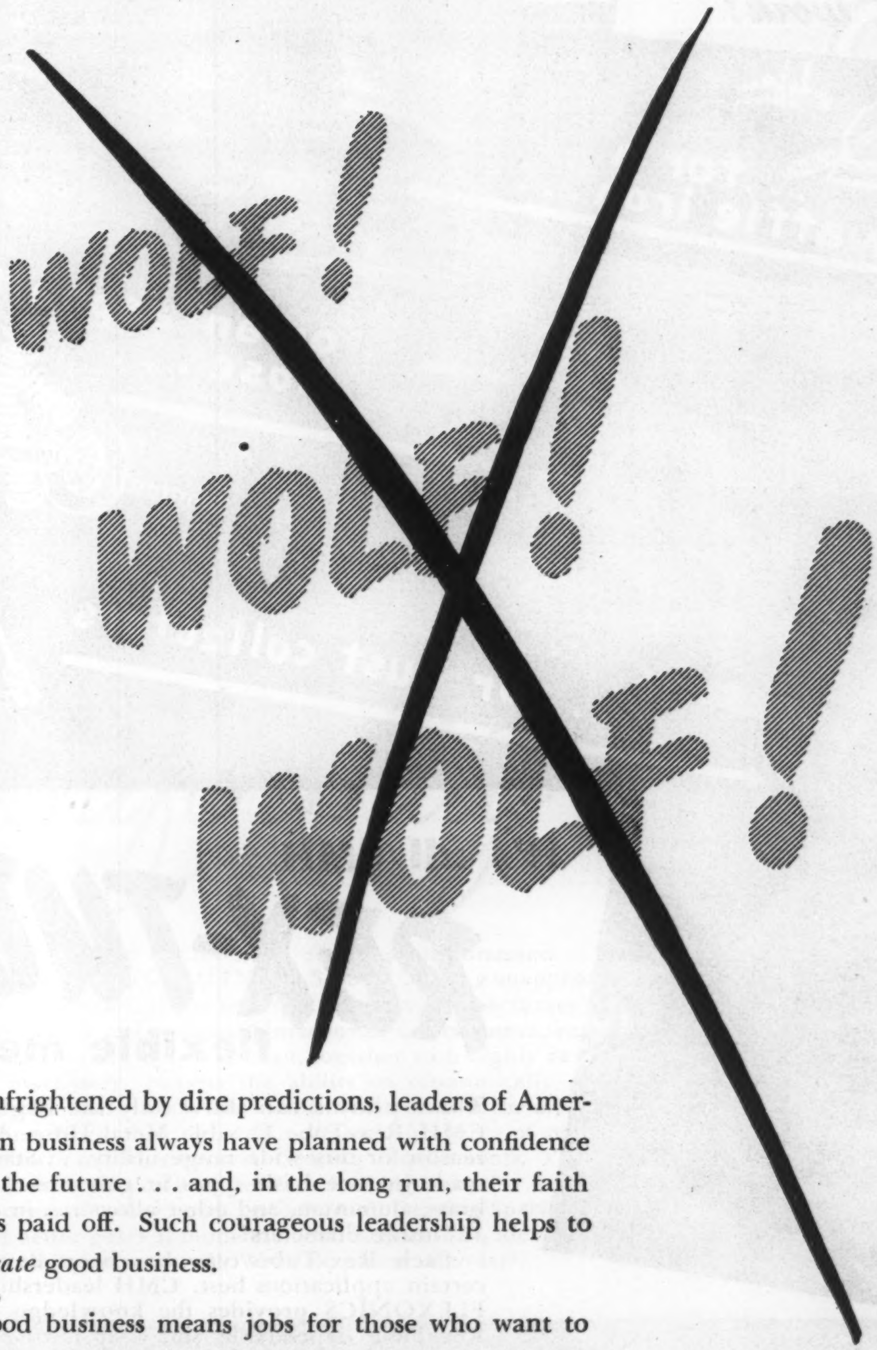
WOLF!
WOLF!
WOLF!

Unfrightened by dire predictions, leaders of American business always have planned with confidence in the future . . . and, in the long run, their faith has paid off. Such courageous leadership helps to *create* good business.

Good business means jobs for those who want to work. It's the best defense against the termites who are working to undermine the individual liberties Americans enjoy. 6593

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at work!
. . . for a
waffle iron . . .
or an asphalt
hose . . .
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REX-TUBE

flexible metal hose!

Three photos can show only the beginning of uses for CMH Rex-Tube Flexible Metal Hose. And there's a good reason for this wide range utility . . . Standard Rex-Tube is made in nine basic types in galvanized and stainless steel, brass, aluminum, and other alloys . . . in sizes from 5/32" to 12" inside diameters!

Each Rex-Tube type has been developed to handle certain applications best. CMH leadership in the science of FLEXONICS provides the knowledge necessary to make Rex-Tube dependable and long-lasting in service where temperature, pressure, vibration or corrosion conditions are usually severe.

Write for data sheets and specifications on CMH Rex-Tube Flexible Metal Hose for your service.

CMH—ONE dependable source
for every flexible metal hose requirement
• CMH manufactures all standard types of flexible metal hose, both convoluted and corrugated, in a variety of metals; expansion joints for piping systems; stainless steel and brass bellows; various conduits and special assemblies of these components.

CMH
CHICAGO METAL HOSE
CORPORATION

Leaders in the Science of Flexonics
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Plants at Maywood, Elgin and Rock Falls, Illinois
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FLEXON . . . . . identifies CMH products which have served industry for more than 47 years.

GS
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[illegible] It illustrates and describes [illegible] different types and applications of G.S. Fractional Horsepower Gears [illegible] valuable aid for anyone [illegible] with Specifying Small Gears [illegible] your copy today. Use company [illegible]

GEAR SPECIALIZES IN *Uniformity*

WHETHER you need *one* thousand or a *hundred* thousand . . you'll get a degree of UNIFORMITY in G.S. Small Gearing unapproached, we believe, in the history of the industry! Such extreme accuracy in the speedy *mass production* of Fractional Horsepower Gears comes from over 30 years of specialization. G.S. craftsmen, together with highly developed methods and machinery, possess the ability to economically produce *quantities* of Small Gears . . each one uniformly cut to meet the most exacting specifications. Here, then, is a really *dependable* source of supply for ALL of your Fractional Horsepower Gearing requirements. Year after year, more and more particular buyers are looking to us for the kind of service and cooperation they need. Let our Small Gearing Specialists also help you to get better gears at moderate cost. Suggestions, ideas, and cost estimates won't obligate you at all. Write or phone us today!

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WORLD'S LARGEST EXCLUSIVE MANUFACTURERS OF FRACTIONAL HORSEPOWER GEARS

HAND POWER TOOLS
helping hand
AIRCRAFT
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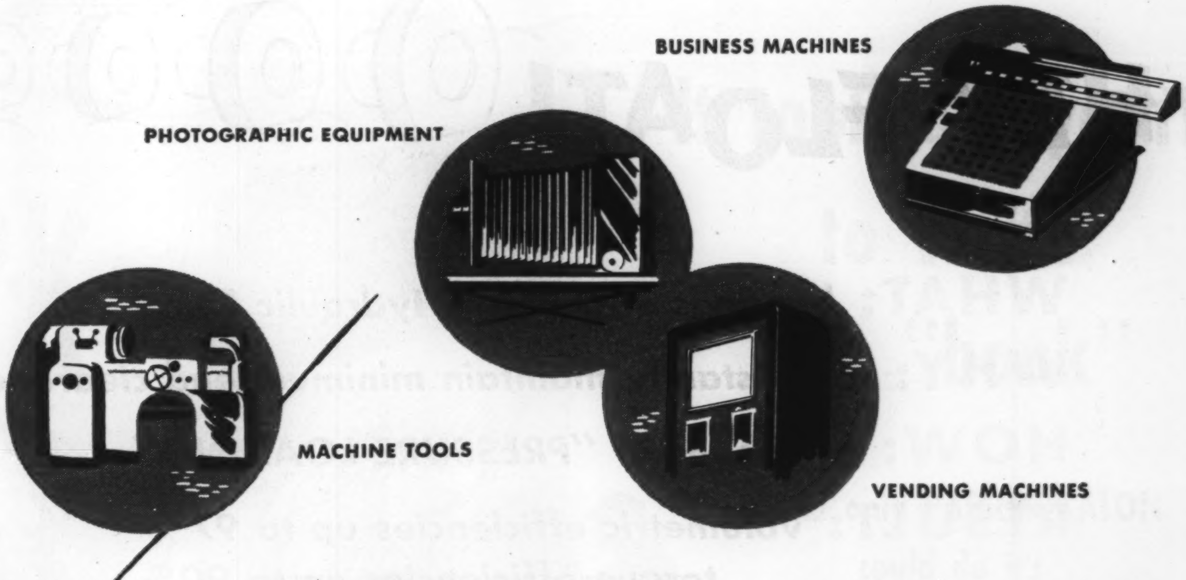
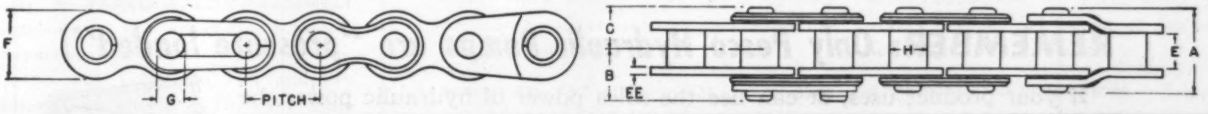


for machine designers!

Machine designers! Here's the newest addition to the complete Baldwin-Rex line of precision-made roller chains. It is the answer to that problem of transmitting positive power where space is limited, where centers are extremely short, where savings in weight and a combination of high strength and accurate timing are required . . . Baldwin-Rex No. 25 Roller Chain. This ¼-inch pitch chain is as finely made . . . as long lasting . . . as versatile and positive as the larger size roller chains. And despite its small size, it has an ultimate strength of 875 pounds . . . an important advantage where reduced maintenance and service are needed.

Hand power tools, juke boxes, animated displays, machine tools, photographic equipment, electronic equipment, television equipment, business machines, model equipment and many other types of high precision, small size equipment can be more efficiently designed with this new helping hand to the designer. In many larger types of equipment, too, this handy little chain can motivate intricate timing functions that must be designed into small space.

For all the facts, write Baldwin-Duckworth Division of Chain Belt Company, 320 Plainfield Street, Springfield 2, Massachusetts.



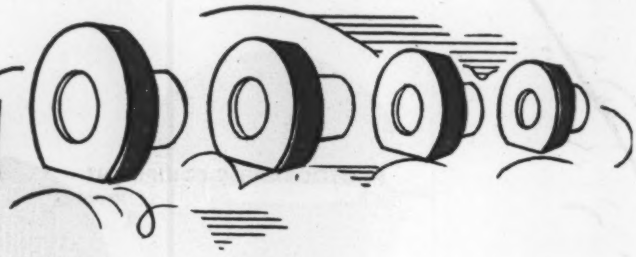
Principal Dimens.			LIST PRICES				DIMENSIONS — INCHES							
	Roller									Side Plate				
Pitch	Width	Diam.	Riveted Chain	Connecting Link	Assembled Roller Link	Offset Link	Overall Riveted	From Pin End to C.L.	From Pin Head to C.L.	Thickness	Height	Pin Diam.	Average Ultimate Strength	Average Weight per Foot
	E	H	Per foot	Each	Each	Each	A	B	C	EE	F	G	Lbs.	Lbs.
¼	⅛	0.130	$1.10	$.14	$.10	$.40	0.31	0.19	0.15	0.030	0.23	.0905	875	.085

BALDWIN·REX ROLLER CHAINS

a complete line from ¼-inch to 2½-inch pitch

BALDWIN-DUCKWORTH DIVISION OF CHAIN BELT COMPANY

THEY FLOAT!



WHAT: *bearings in a Pesco Hydraulic Pump*

WHY: *to constantly maintain minimum end clearance*

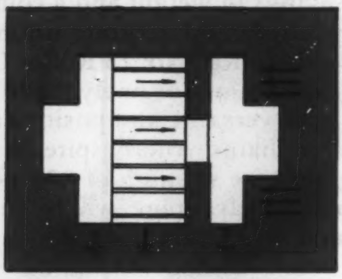
HOW: *by means of "PRESSURE LOADING"*

RESULT: *volumetric efficiencies up to 97%*
. . . torque efficiencies up to 90%

"Pressure Loading" is an exclusive, patented Pesco principle of construction for gear type hydraulic pumps. By *automatically* holding end clearance to a thin film of oil, maximum torque and volumetric efficiencies are obtained under all operating conditions. New pump efficiency is maintained throughout the long service life of the pump since "Pressure Loading" provides an *automatic* take-up of wear.

THIS IS "PRESSURE LOADING":

The schematic illustration at right shows the three principal parts of a gear type hydraulic pump. They are the bearings ("A" and "C") and the gear ("B"). Bearing "A" is fixed. Bearing "C" "floats". By means of the "Pressure Loading" principle, pressure from the discharge of the pump is transmitted through a "pressure loading" passage and is exerted against the rear of the "floating" bearing (arrows). This force is counterbalanced by the pressure developed within the gear cavity so that the thrust of the bearing against the gears is just enough to accomplish its purpose.



REMEMBER: *Only Pesco Hydraulic Pumps are "pressure loaded"!*

If your product uses, or can use the sales power of hydraulic power, be sure to get the full story of "Pressure Loading" and what it means to the efficient, economical operation of your product. Write for the booklet "Pressure Loading by Pesco". There is no obligation.

Pesco PRODUCTS DIVISION
BORG-WARNER CORPORATION
11610 Euclid Ave. - Cleveland 6, Ohio

MANUFACTURERS OF BW SUPERCHARGERS

P-K
Fastening Applications
Nos. 1,000,000
1914-1949

It took 35 years to write this "book"

...and only PARKER-KALON could do it!

ORIGINATORS of the Self-tapping Screw, pioneers in new designs, and *specialists* in the manufacture of this type of fastening, Parker-Kalon alone can offer the wealth of invaluable information represented by this "volume". That's why . . .

more **Fastening-wise Manufacturers Call on Parker-Kalon**

More "know how" is just one of the *extras* you get when you choose P-K Self-tapping Screws. Look at all these advantages:

CALL IN A PARKER-KALON ASSEMBLY ENGINEER and let him apply this unparalleled experience to your assembly problems. Find out how you can simplify assemblies, improve strength, save time and lower production costs with the simpler P-K method. If you prefer, mail assembly details for recommendations. Parker-Kalon Corporation, 200 Varick St., New York 14, N. Y.

MORE "SHOW HOW" — P-K's staff of Assembly Engineers has helped solve nearly a million application problems.

MORE TYPES AND SIZES — With a complete line of Self-tapping Screws for every metal and plastic assembly, P-K's advice is unbiased.

MORE EXACTING QUALITY CONTROL — P-K's investment in laboratory testing and inspection equipment is unsurpassed.

MORE PRODUCTION — Parker-Kalon is the world's leading manufacturer of Self-tapping Screws.

MORE TOP-RATED DISTRIBUTORS — Everywhere throughout the nation, P-K Self-tapping Screws are readily available.

AND NOW . . .
PROMPT DELIVERIES from stock on most types and sizes

REMEMBER . . . YOU'RE *O.K.* WITH *P-K!*

P-K® *The Original*

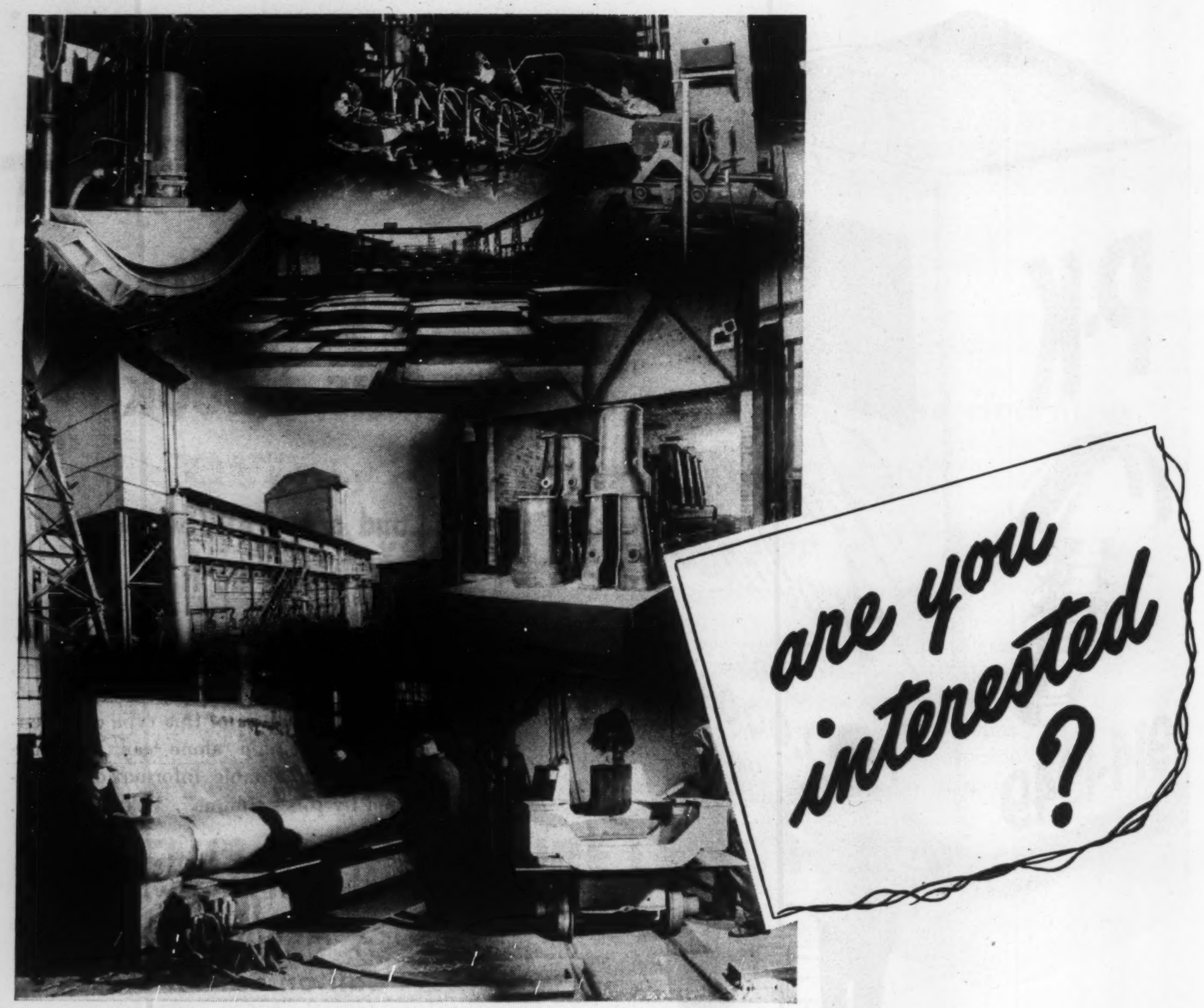
PARKER-KALON SELF-TAPPING SCREWS

FOR EVERY METAL AND PLASTIC ASSEMBLY

A
Z
HEX HEAD
Z
A, Z, F, F-Z AVAILABLE WITH PHILLIPS HEAD
F
U
F-Z

P-K Also Makes
Cold-forged
THUMB SCREWS
WING NUTS

OTHER P-K PRODUCTS: Cold-Forged Socket Screws, Wing Nuts, Thumb Screws • Hardened Screwnails and Masonry Nails • Shur-Grip File and Solder Iron Handles • Metal Punches • Damper Regulators and Accessories



Weldments by

- Are you interested in a STEEL FABRICATOR who can serve you with . . .

DESIGN— thorough understanding of your problem, intelligently conveyed to an experienced engineering department and translated into a weldment design that will fit your specific requirements . . .

SHOP EQUIPMENT—adequate weldery facilities for flame cutting, shearing, forming, bending, rolling, punching, machining, assembling, welding, stress relieving, shot blasting, and painting . . . *Machinery* such as large plate rolls, large press brakes, multiple torch flame cutters, giant shears, extra large and complete stress relieving equipment . . . *Testing*—all types of hydrostatic and air . . . *Inspection*—visual, X-ray or Magnaflux . . .

PURCHASING POWER— sufficient to obtain material in large quantities at lower price . . . supply maintained at high level . . .

PROMPT DELIVERY— consistent with material availability on even the largest weldments.

If you seek such service with complete cognizance of quality, economy, and assured satisfaction, CALL ON GRAVER. Send us your prints for engineering recommendations and quotations.

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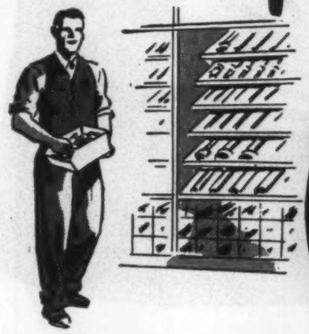
Everybody's sold on PARKER-KALON SIZE-MARKED socket head cap screws



Tool Crib bosses

like 'em because [illegible] correctly [illegible] eliminates waste.

Assembly workers

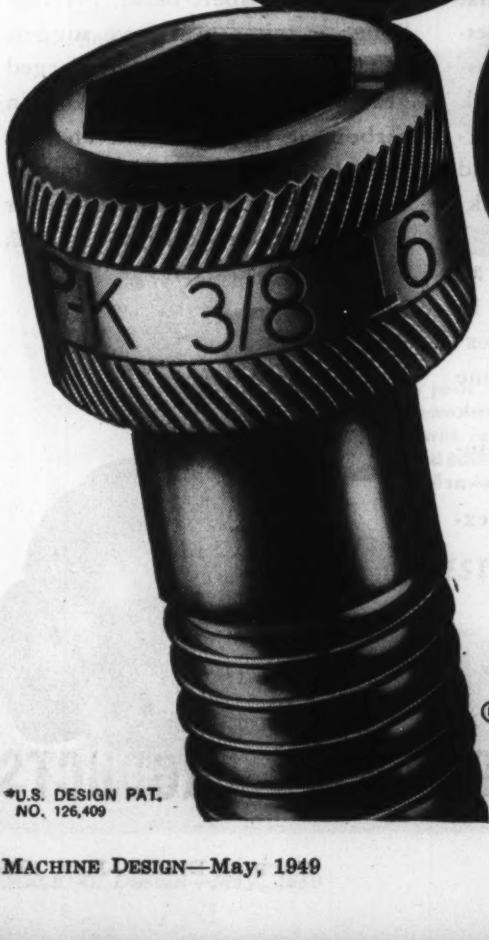
like 'em because they can spot the right size at a glance, [illegible]

Apprentices

like 'em because the correct size and thread pitch, clearly marked on the screw head, helps them learn faster . . . work faster.

Yes, and Sales managers

like 'em — they [illegible]



**with GEAR-GRIP*
-fingers won't slip**

Parker-Kalon Gear Grip prevents fingers from slipping even when oily. Makes fast fingers *sure* fingers.

ONLY ON PARKER-KALON Socket Screws will you find the Size-Mark and Gear Grip . . . developed after extensive study of shop practice to speed work. Samples Free, on request. See why P-K "years ahead" Socket Screws can put your product out front, assembly-wise as well as sales-wise. Send for Stock List Now. Parker-Kalon Corporation, 200 Varick Street, New York 14, N. Y.

®PARKER KALON *cold forged* SOCKET SCREWS

AVAILABLE THROUGH ACCREDITED DISTRIBUTORS IN EVERY INDUSTRIAL AREA

*U.S. DESIGN PAT. NO. 126,409

G stands for
GOOD
it also stands for
GEARS

Good gears start with good blanks, and now we'd like to work in B for Bethlehem. Frankly, we don't think it's possible to purchase a better forged gear blank than Bethlehem makes, and this viewpoint is borne out by customer experience.

You might well ask, "What's so different about the ones Bethlehem makes? Aren't all forged gear blanks made alike?"

Not by any means! The Bethlehem process, to the best of our knowledge, is the only one of its kind in the country. Our gear blanks—and round blanks for many other uses—are made in a three-way mill that combines the operations of upsetting, forging, and rolling. It's almost like magic, the way the heated block of steel goes in, then emerges seconds later, forged and rolled and shaped to predetermined thicknesses and contours.

This method of ours means an extra-good product. It results in homogeneity . . . strength . . . excellent grain structure . . . fine surface characteristics. Every blank is given a beautiful rough-machining job before it is shipped—a service that saves you time and expense in your own plant.

If you make spur, bevel, herringbone, or miter gears, we suggest you investigate Bethlehem forged gear blanks. They are available in carbon or alloy steel, treated or untreated; sizes range from approximately 10 in. to 42 in. OD. For more details, request Booklet 216.

BETHLEHEM
STEEL

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation
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BETHLEHEM ROLLED-AND-FORGED CIRCULAR PRODUCTS

SPECIALS

FORMETAL

BUSHINGS AND BEARINGS

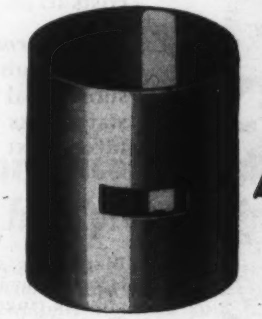
and they still cost less!

There's no miracle about our being able to give you bushings and bearings at substantial savings. The reason is—what might seem like a "special" to you is standard production with us.

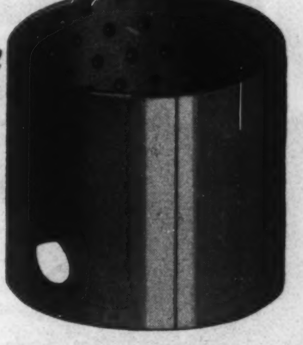
For example, in a Formetal bushing, you can have alloys with a higher Rockwell hardness without loss of machinability. Oil grooves, oil holes or cut-outs and other special requirements can be readily engineered to your exact need.

If you use bushings or bearings ... and keep it a secret ... we can't help you. But if you write us, our engineering staff will tell you quickly whether or not we can save you money and improve your product. There's no obligation so why not find out today? Our handy catalog is available for the asking!

...TO GET YOUR
PRODUCTS REALLY
ROLLING ... USE
FORMETAL
Superformed
BUSHINGS AND
BEARINGS



Auto parts manufacturer replaced ordinary bushings with Formetal Superformed Bushings. Effected annual savings of $16,800.



Auto assembly manufacturer changed to Formetal Superformed Bushings—improved performance of assembly and saved $18,600 annually.

A motor manufacturer substituted Formetal Bearings for those previously used. Result: he saves $13,800 annually.

LARGEST MANUFACTURERS OF SPACER TUBES IN THE WORLD

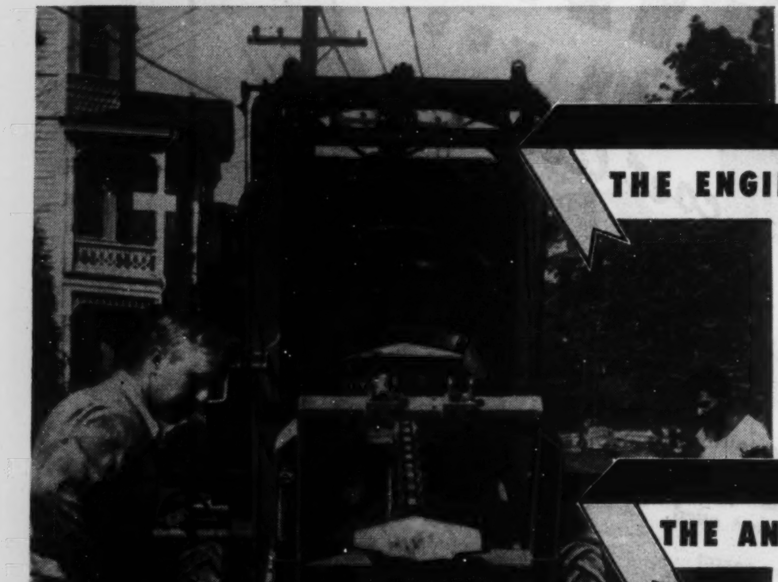
FORMETAL

NATIONAL FORMETAL COMPANY, INC.
ESTABLISHED 1919
Manufacturers of "Superformed" Bushings and Bearings...and Spacer Tubes
4604 METTA AVENUE **CLEVELAND 14, OHIO**
Offices in DETROIT • CHICAGO • LOS ANGELES • NEW YORK • KANSAS CITY, MISSOURI • CANADA

LOOK HOW BLACKHAWK®

*High-Pressure Hydraulics**

SOLVED THIS MANUFACTURER'S PROBLEMS



THE ENGINEERING AND SALES PROBLEMS:

Here are the fourfold necessities which faced the maker of this well-known "Trencher": (1) The need to abandon antiquated mechanical methods; (2) to make the change-over to hydraulics without upsetting design of his machine; (3) to use existing power facilities and (4) to retain low cost despite the modernization.

THE ANSWERS SUPPLIED BY BLACKHAWK:

(1) *Compactness* and *adaptability* of Blackhawk hydraulic components eliminated need to revise the basic design of the "trencher."

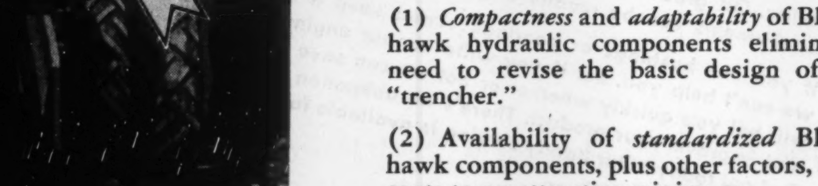
(2) Availability of *standardized* Blackhawk components, plus other factors, held costs to an attractive minimum.

(3) *Performance* and *dependability* of Blackhawk High-Pressure Hydraulics produced substantial sales and service benefits (see statements by the "Trencher" manufacturer, next page.)

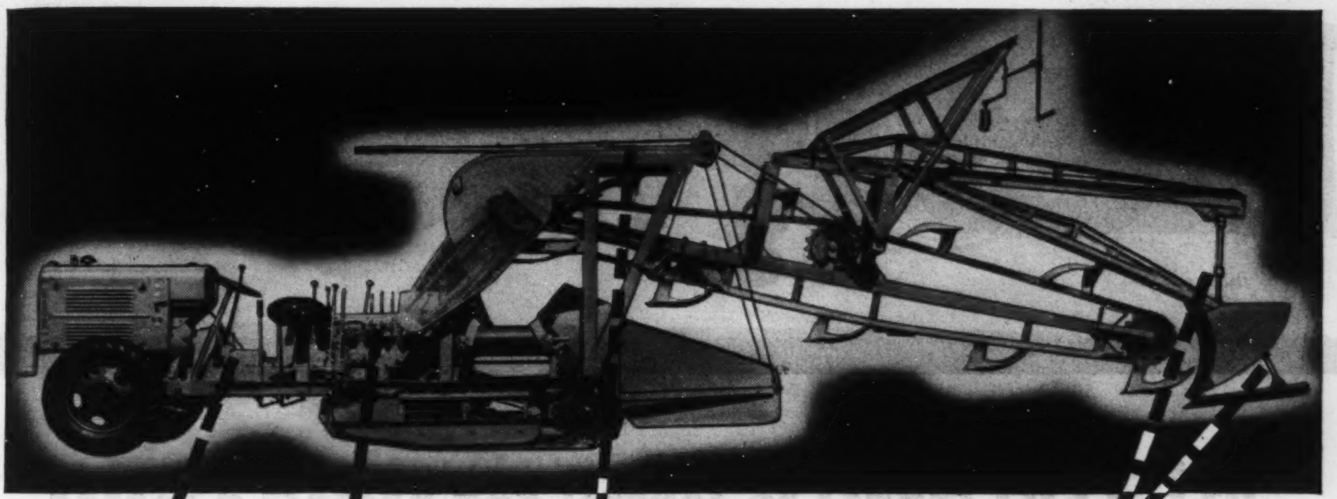
* Blackhawk specializes in engineering and manufacturing hydraulic components and systems with pressure ranges from 1,000 p.s.i. up to 10,000 p.s.i. These higher pressures create unusual benefits. Blackhawk PUMPS and VALVES (because of higher pressure capacities) are strikingly compact and RAMS have smaller diameters. The entire hydraulic system gains from (1) less weight, (2) easier installation, (3) less friction, (4) improved appearance, (5) simplicity, (6) lower cost and (7) easier service.

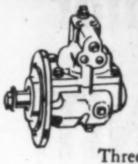
BLACKHAWK HYDRAULIC EQUIPPED

AN EMBLEM REPRESENTING DEPENDABILITY THROUGHOUT INDUSTRY

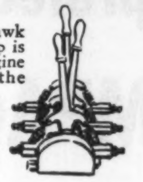


PIONEER SPECIALISTS IN HIGH-PRESSURE HYDRAULICS FOR 25 YEARS

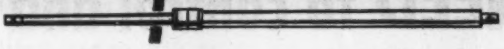




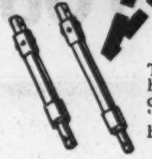
A *standard* Blackhawk power-driven pump is driven by the engine which powers the "Trencher".



Three *standard* Blackhawk *valves* are ganged together near the operator's seat. They control all three rams.



This 47" stroke Blackhawk *Ram* operates the "Trencher's" boom. It eliminated *"a friction drive winch which constantly required service and was anything but simple to operate."* This 2" diameter ram was developed from a standard Blackhawk design easily varied as to length. To withstand weather, its plunger is *chromium plated* (practical because, when the "Trencher" is idle this plunger is generally exposed).



Two *standard* Blackhawk *Rams* are incorporated in the "Trencher's" grade holder.

Listen...

TO WHAT THE MANUFACTURER OF THIS LEADING "TRENCHER" SAYS ABOUT BLACKHAWK HYDRAULICS:

Regarding Control

"A grade can be maintained . . . to satisfy . . . the more critical surveyor or engineer."

Regarding Operation

". . . operations that were once difficult are now simple and easy to control."

Regarding Service and Sales

". . . performance has been very good with no service worries or problems . . . *hydraulic equipment has materially advanced our sales.*"

Regarding Engineering

". . . assistance rendered us thru your engineering department . . . was most helpful."

Sensible costs, practical design are no accident at Blackhawk...

they are born from proven Engineering and Manufacturing policies

Only with Blackhawk can you draw from a quarter-century of experience in engineering and manufacturing of high-pressure hydraulic equipment! And you get more than the invaluable benefits of high-pressures . . . you also benefit from exclusive refinements built into Blackhawk components.
Comparatively, Blackhawk's PISTON-TYPE pumps furnish greater volumetric efficiencies in the higher pressure ranges—and Blackhawk offers a host of other exclusives in ram and valve designs.

"Standards" or "Specials". . . Blackhawk furnishes components that are of standard design, continuously produced and sold in quantities for installation on products of other manufacturers. A great many manufacturers also depend on Blackhawk for specially-designed hydraulics to fit individual needs. Blackhawk has the engineering service for this work. Blackhawk products and integrated services are cataloged in profusely illustrated literature. Ask for bulletins on "High-Pressure Hydraulics," then let us counsel in confidence.

BLACKHAWK MFG. CO., 2020 S. 54th St.. Milwaukee 1, Wisconsin

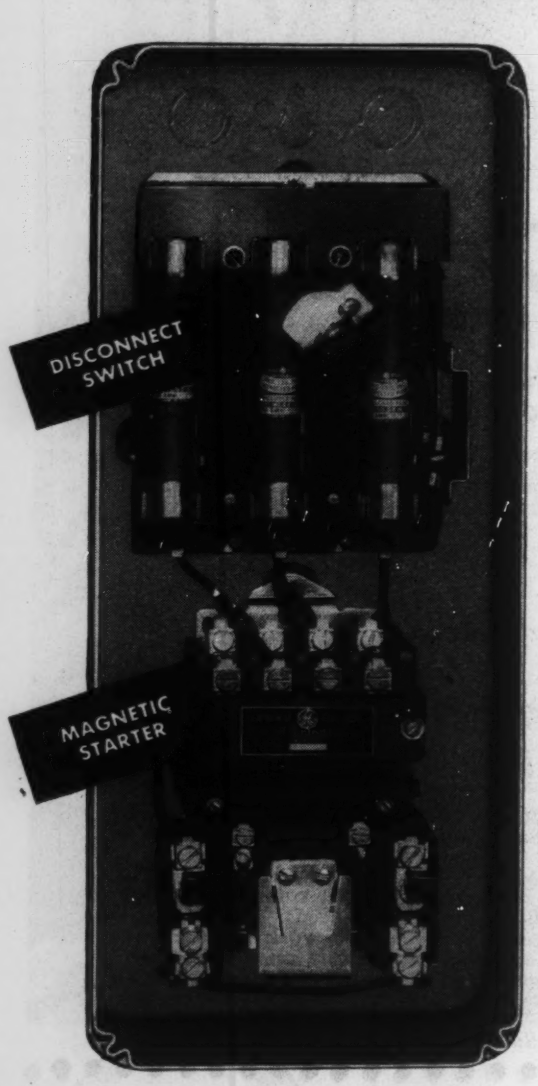
• •

BLACKHAWK®

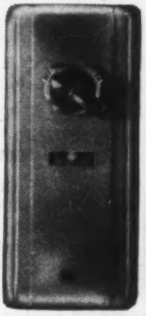
COMPLETE HYDRAULIC SYSTEMS—PUMPS (HAND AND POWER-OPERATED), VALVES AND RAMS

Designer's

ALL YOU NEED to control and protect a motor IN ONE COMPACT UNIT



ALL-NEW COMBINATION STARTER



All new all the way through! That's the General Electric full-voltage combination a-c motor starter, designed and built for reliable operation, easy maintenance, and long life. A compact, easy-to-mount unit, it combines contactor and its overload relays with disconnect switch and fuses. You get both motor overload *and* short-circuit protection!

Cuts installation time Starter and disconnect switch are wired together to be installed as one unit. No extra time or money need be spent on interconnections.

Saves space This one unit takes up less space than separately mounted devices. Its streamlined case means improved machine appearance.

Increases personnel safety New rotary-action disconnect switch makes it impossible to open the cover without opening the circuit. Switch handle and cover can both be padlocked to insure complete protection of personnel.

Made in NEMA sizes 0, 1, 2, and 3 for a-c motors up to 50 hp. Get the full story in Bulletin GEA-5156.

GENERAL ELECTRIC

Digest

PRODUCT HIGHLIGHTS

MEASURES THROUGH THICK OR THIN!

To make sure coatings or linings on production parts are not so thin as to be insufficient, nor so thick as to be wasteful, use a General Electric thickness gage. It quickly, easily measures any non-magnetic material on magnetic iron or steel without marking the finished surface. Simply place the gage head against one side of the coated surface, and an instrument indicates the thickness. Three types available cover a range from 0.00005 to 0.750 inch. Shown is Type A, measuring copper plating thickness on electronic tube parts. See Bulletin GEC-319.

GIVES LOW-COST SPEED ADJUSTMENT!

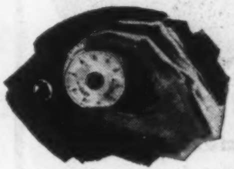
Here's the abridged edition of General Electric's Thy-mo-trol drive—the low-cost Type H1. Utilizing a simplified half-wave electronic circuit, it provides stepless speed adjustment for constant-torque loads over a 20 to 1 speed range from 1725 to 86 rpm. Where close speed regulation and full torque at low speeds are required—but not all the refinements of conventional Thy-mo-trol—the H1 offers an ideal drive at a lower price. Ratings up through ½ hp are available. See Bulletin GEA-5179.

COVERS 90 TESTING DEVICES!

SPECIALIZED
TESTING AND MEASURING
EQUIPMENT CATALOG

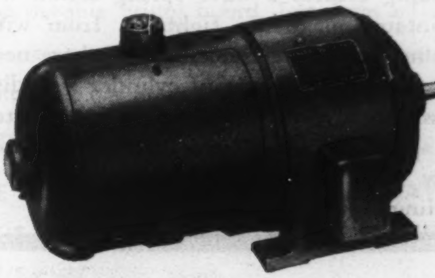
Want a quick round-up of data on specialized testing and measuring devices? This comprehensive, illustrated booklet reviews more than 90 modern General Electric equipments for that purpose. Included are weights, dimensions, and prices, plus references to individual publications containing more detailed information. Convenient grouping under eleven "use" headings lets you locate specific items of interest quickly and easily. See Bulletin GEA-639.

Dial Service for Motor Speeds



Just turn the dial on this General Electric Type ACA adjustable-speed induction motor for quick speed changes, infinitely adjustable over a 3 to 1, 6 to 1, or 20 to 1 speed range. Add a 10-foot flexible cable (for the smaller motor ratings) and you can still dial your speeds. With a pilot motor instead, you can dial from *any* distance.

Compact and self-contained, the ACA is only slightly longer than a constant-speed motor of comparable rating. Standardized NEMA dimensions are used to avoid any new mounting problems. Ratings from 3 to 75 hp are available in Tri-Clad open (dripproof) construction. See Bulletin GEA-4883.



General Electric Company, Section E668-73
Apparatus Department, Schenectady 5, N. Y.
Please send me the following bulletins:

- ( ) **GEA-639—Testing and measuring equipment catalog**
- ( ) **GEA-4883—ACA adjustable-speed motors**
- ( ) **GEA-5156—Combination starters**
- ( ) **GEA-5179—Type H1 Thy-mo-trol drives**
- ( ) **GEC-319—Thickness gages**

CONSULT YOUR McGRAW-HILL ELECTRICAL CATALOG FOR PRODUCT ENGINEERS! You'll find "everything electric" for machinery manufacturers in the General Electric section.

Name...

Company...

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Newest Victor Gasket Designs for High Compression Engines

VIC-2-BEAD

TRADE MARK

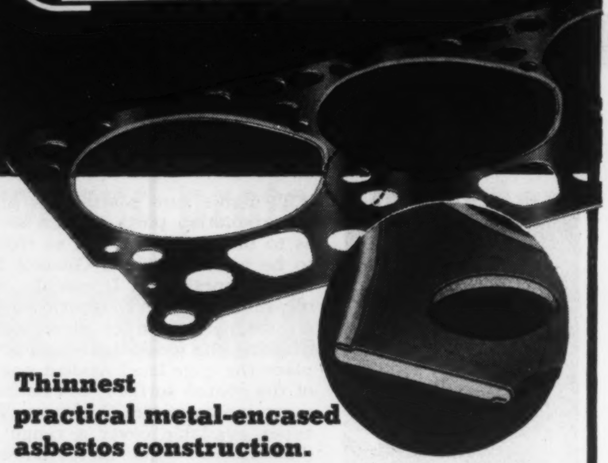
Dual-beaded thin metal. Proved in both L-head and Valve-in-head engines. Compressed thickness to .020

VIC-2-BEAD is the first thin metal gasket to effectively seal both types of engine heads at high compression ratios. It already has the acceptance of the automotive industry.

Sealing with VIC-2-BEAD does not depend on contact with the flat surface of the gasket. Seal is made by the precisely blended, embossed dual-beading around all combustion and coolant openings. When compressed, the beading creates a wave spring action which maintains maximum tightness from within. Sealing forces are concentrated where needed most, without danger of cylinder wall distortion. Once studs or cap screws are tightened to specified torque, retightening is unnecessary due to VIC-2-BEAD's sustained live sealing action.

VIC-2-FOLD

TRADE MARK



Thinnest practical metal-encased asbestos construction. Compressed thickness on engine .040

VIC-2-FOLD meets the requirements of modern high compression engines with the thinnest practical construction for a compressible metal-asbestos gasket. Combines the high breakdown resistance of steel, and the corrosion resistance of copper. Bottom steel layer is formed up in combustion openings to overlap the asbestos filler and copper top layer. The copper top layer is formed down into all waterways, and overlaps the bottom layer.

VIC-2-FOLD excels standard construction for flexibility, and has adequate compressibility for positive sealing in all applications. It has all desirable features of a general purpose gasket, equally suited for Valve-in-head and L-head engines, in gasoline or diesel service.

COMPLETE TECHNICAL DATA on these newest Victor designs supplied on request. Ask your Victor Representative or write today. Victor Mfg. & Gasket Company, P. O. Box 1333, Chicago 90, Illinois.

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SHORT CUT MOTOR CONTROL LAYOUTS

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A-H TEMPLATES are just another service offered by Arrow-Hart to help you get the best physical and functional use of Motor Controls in your product design.

Here's a new idea that will save man-hours, eliminate guesswork and expensive planning and drawing. Arrow-Hart Templates — actual-size templates of Arrow-Hart Motor Controls printed in sharp, black outline on durable bristol board. Templates offer a practical, accurate means of visualizing space arrangements and limitations; are ideal for roughing-out and for tracing.

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HARTFORD 6, CONN., U. S. A.

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Slips into a suitcase

FRESH'ND-AIRE
FANETTE
CHICAGO

the SALES APPEAL of the Fresh'nd-Aire FANETTE came from GENERAL AMERICAN'S Plastics Division

Fresh'nd-Aire Company saw the need for a low-cost, light-weight highly attractive electric fan that could be recognized immediately as a "portable." So, like leading manufacturers in other industries, they turned to General American.

Working with a noted designer, and Fresh'nd-Aire engineers, General American developed the beautiful, sales-appealing Fanette. Molded of a durable, smooth, green plastic, the Fresh'nd-Aire Fanette is an example of General American's skill in developing practical, saleable plastic products for customers.

GENERAL AMERICAN CAN SERVE YOU, TOO!

If your part or product needs the distinctive sales appeal that only plastics can give—come to General American. Expert counsel and tool and die shops are available. Molding can be done on equipment unequaled anywhere—2 oz. to 48 oz. injection presses and compression presses up to 2000 tons with 71" x 74" platen areas.

PLASTICS DIVISION
GENERAL AMERICAN
TRADE MARK

Plastics Division—General American Transportation Corporation
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Based on Bearing Performance Records

NEEDS NO
LUBRICATION

Westinghouse
says
"do away with lubrication costs"
IN THEIR LIFE-LINE MOTORS

"Forget old-time ideas about the care and greasing needed to keep motors running!

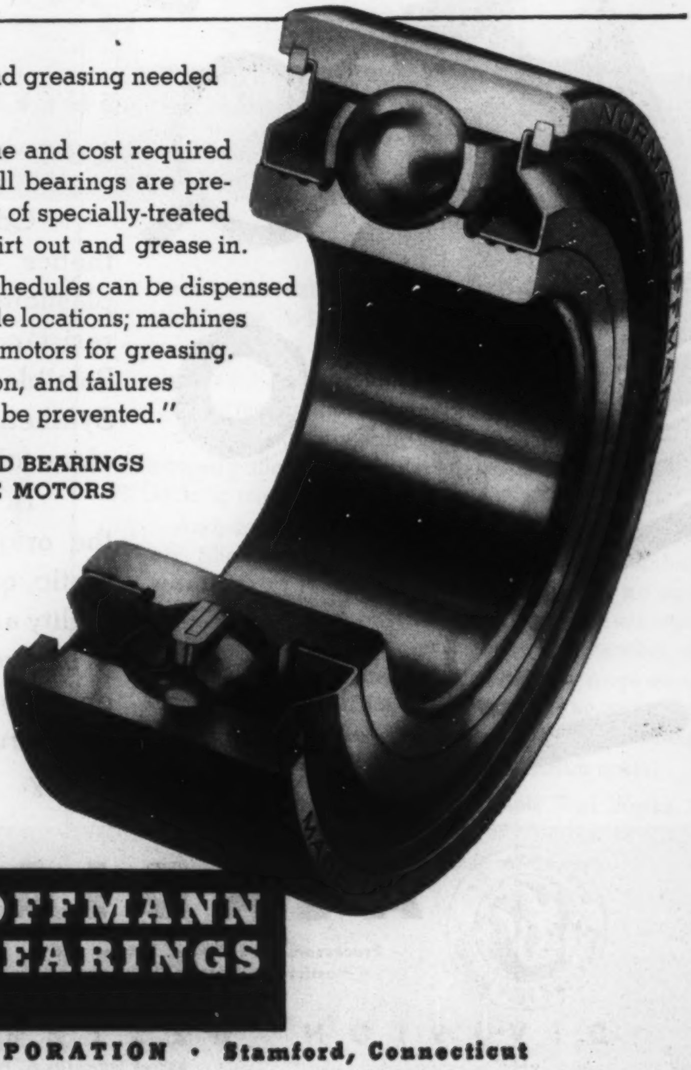
"Life-Line motors now eliminate the time and cost required for lubrication. Life-Line double-width ball bearings are prelubricated with a more-than-ample supply of specially-treated lubricant — and factory-sealed to keep dirt out and grease in.

"Periodic weekly or monthly greasing schedules can be dispensed with. Motors may be installed in inaccessible locations; machines no longer need be disassembled to reach motors for greasing. Winding failures caused by overlubrication, and failures caused by use of improper lubricants, can be prevented."

NORMA-HOFFMANN "CARTRIDGE" SEALED BEARINGS ARE USED IN WESTINGHOUSE LIFE-LINE MOTORS

With their extra large initial grease supply, made possible by their double width and with highly efficient seals insuring against grease leakage, Norma-Hoffmann "Cartridge" bearings give years and years of service without relubrication. They are prepacked with a carefully metered volume of oxidation-resistant and wide temperature range grease.

Whether you are building motors, machine tools, pumps, fans or other equipment, let our Engineers show you how you may eliminate lubrication costs and simplify your designs by using these "neglect proof" Cartridge ball bearings.

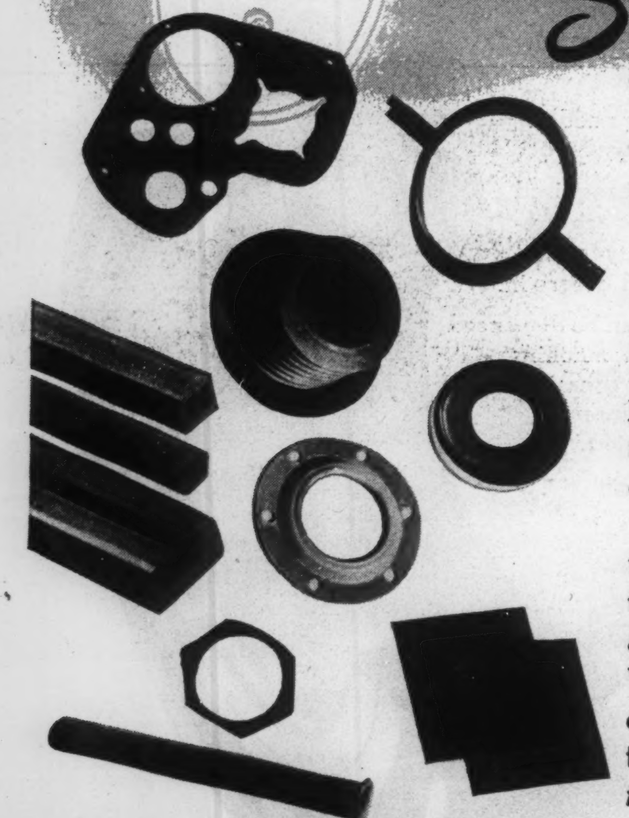


NORMA-HOFFMANN
***Precision* BEARINGS**

NORMA-HOFFMANN BEARINGS CORPORATION • Stamford, Connecticut

For Superior Performance...

DESIGN with ACADIA Synthetic Rubber



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CUT AND MOLDED PARTS

Component parts processed from Acadia Synthetics excel in many characteristics—including plasticity, elasticity, resilience, etc.—plus greater resistance to light, air, heat, wear, oil and age. Possible applications are almost unlimited. Acadia Synthetic Rubbers cut, mold and extrude to very close tolerances—in any shape, size or type.

In checking specifications, you may find that the original part, re-designed in an Acadia Synthetic, gives superior performance, greater dependability and longer service—*very often at lower cost.* Whatever your requirements may be . . . Acadia's engineers will gladly help you select the right synthetic rubber and adapt it to your product. *Write today.*

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SEE HOW *Pre-assembly* REDUCES PRODUCTION COSTS

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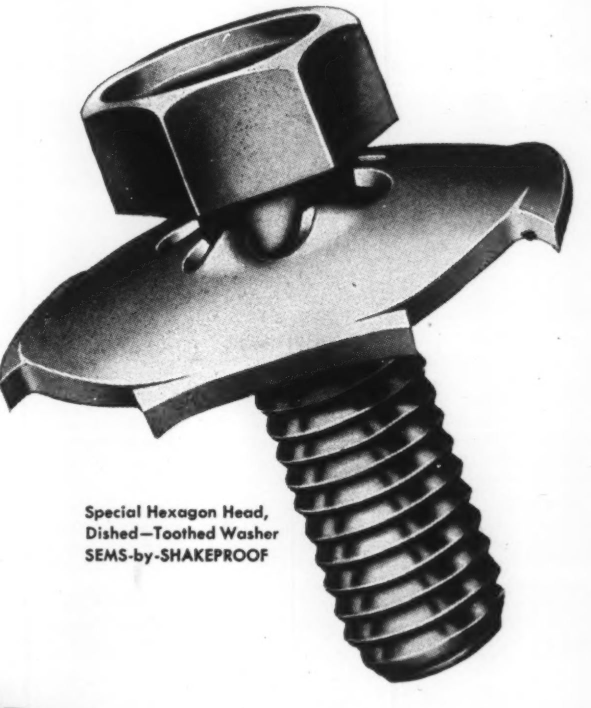
Standard Round Head, External Washer SEMS-by-SHAKEPROOF

TESTING SAMPLES
SEMS-by-SHAKEPROOF

SEND FOR THIS FREE SAMPLE KIT!

Test SEMS by SHAKEPROOF on your own assembly . . . check the many advantages that this modern fastener unit provides!



Special Hexagon Head, Dished—Toothed Washer SEMS-by-SHAKEPROOF

Here's what SEMS-by-SHAKEPROOF will do for you: eliminate separate lock washer handling completely . . . prevent lost lock washers or shortages that cause costly delays . . . assure tight, vibration protected fastenings. You get maximum vibration protection because each lock washer is automatically positioned for greater locking power, pulled closer under the screw head for maximum locking tooth engagement.

And, for even greater economies through *pre-assembly*, Shakeproof engineers have developed hundreds of special SEMS-by-SHAKEPROOF combinations for specific applications. The typical example shown at left replaces three separate pieces . . . a screw, a lock washer and a spanner washer . . . and provides a better, more economical fastening! Send for your *free* SEMS-by-SHAKEPROOF sample kit today! See how these modern, *pre-assembled* fastener units will reduce your production costs!

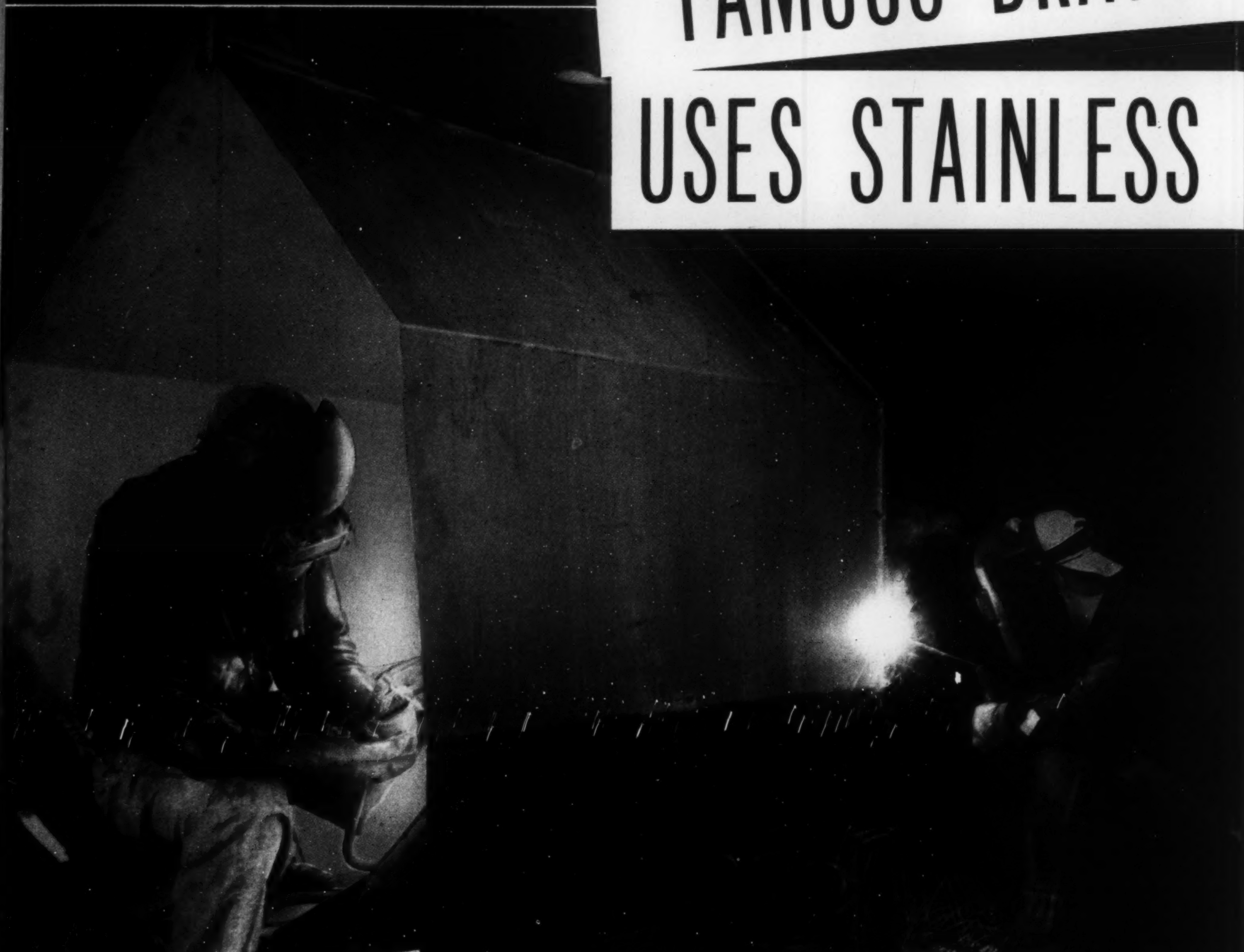
SHAKEPROOF inc., Division of Illinois Tool Works, 2501 North Keeler Avenue, Chicago 39, Illinois. In Canada: Canada Illinois Tools, Ltd., Toronto, Ontario.

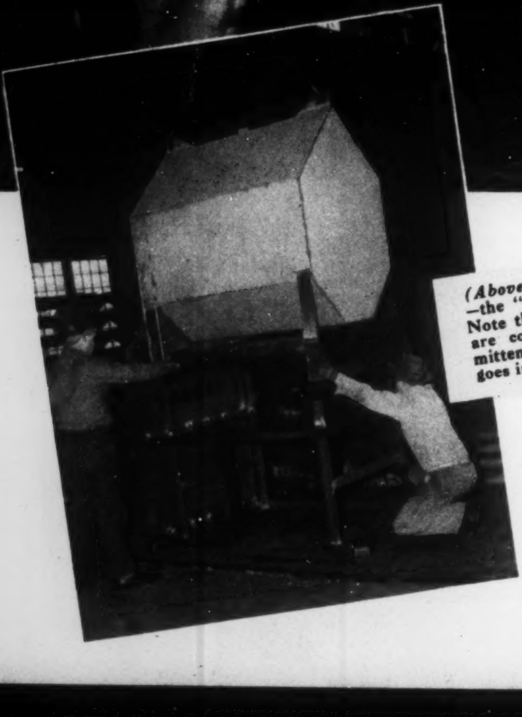
FASTENING HEADQUARTERS
TRADE MARK

SEMS -by-SHAKEPROOF

Who said it costs more to use Stainless Steel?

FAMOUS DRAVO USES STAINLESS



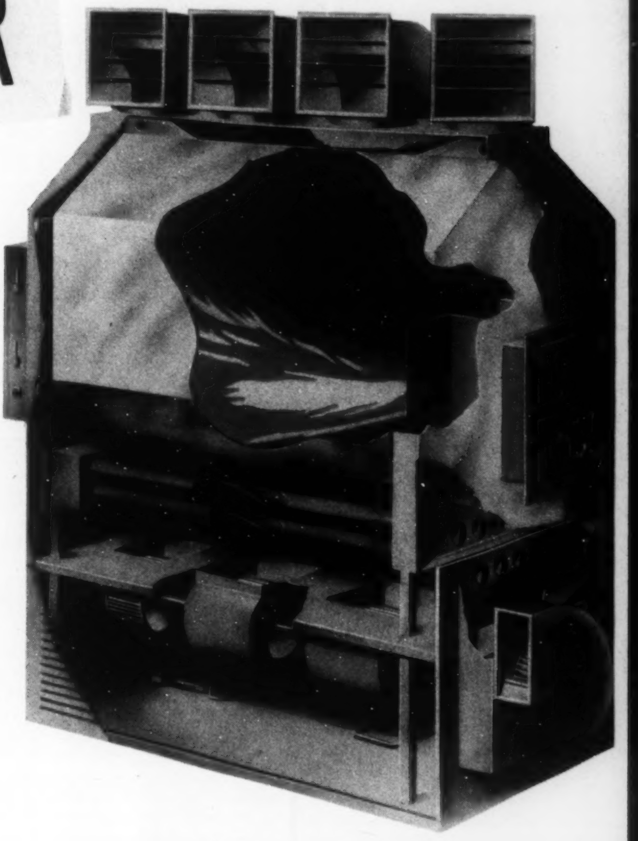


(Above) The Stainless Steel combustion chamber—the "heart of the heater"—takes finished shape. Note the simplicity of construction. Outer seams are continuous-welded, inside seams are intermittent. *(At left)* The completed Stainless chamber goes into the frame as a unit.

(At right) Outer casting goes on. Fastened with sheet metal screws, panels can be easily and quickly removed. Asbestos gaskets make joints air-tight. Mass production methods insure uniform, speedy manufacture.

Counterflo HEATER

TO REDUCE COSTS!



Completely self-contained, automatic in operation, this direct-fired heater provides an entirely new solution to the troublesome problem of plant heating. A "single-package" heating unit that can be positioned anywhere, it supplies heat directly to the area needing it, efficiently and economically.

Incidentally, it also proves that using Stainless Steel does not necessarily increase cost, but on the contrary, can decrease it.

THE heart of any heater is the combustion chamber. In the original Dravo Heater sold by the thousands to army camps and plants during the war, this chamber was made of corrugated carbon steel lined with refractory cement. Numerous fins and deflectors were welded to its outer surface.

To meet the tremendous civilian demand created by its highly successful war-time service, Dravo engineers recently redesigned the heater to increase its efficiency, to reduce its size and weight, to increase its life span, to make its operation safer. And in order to maintain prices in the face of rising labor and material costs, they took steps to speed up its production and to reduce manufacturing costs. They accomplished these things mainly by building the combustion chamber of Stainless Steel.

By specifying Stainless Steel that withstands temperatures up to 1600°F. they got rid of the troublesome and maintenance-demanding refractory lining. The unlined chamber, with its entire surface now exposed to the flame and gases, greatly increased heat transfer. This made it possible to eliminate fins and deflectors, allowed them to build the chamber smaller (to reduce its heating surface 53% without reducing operational performance) . . . and to reduce its weight 1500 pounds.

In addition, the simplified chamber design obtained by the use of Stainless Steel reduced the number of fabricating operations from 95 to 67. And, even though welding with Stainless requires more care, welding costs too were reduced because only 186 lineal feet of welding were required instead of 400 feet.

● To indicate how U·S·S Stainless Steel might benefit *you* in similar constructions, we recapitulate the benefits Dravo has obtained by using Stainless:—It has enabled them to employ less expensive manufacturing procedures than those used previously. It has insured greater portability for their equipment. It has improved heat transfer and eliminated expensive refractory maintenance. Dravo is now sold on the use of Stainless Steel because, as their engineers report, it has given them a tremendous advantage over competition in many respects, one of the most important being *lower cost of manufacture.*

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☐ **Please send me the new book, "An Introduction to U·S·S Stainless Steel."**
☐ **Please have a Stainless representative call on me.**

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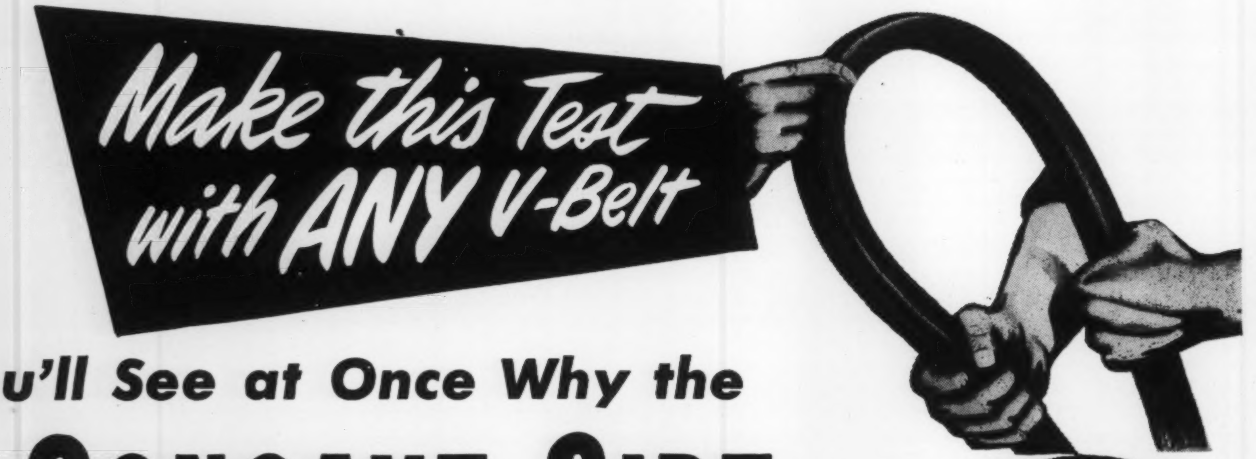
U·S·S STAINLESS STEEL

SHEETS · STRIP · PLATES · BARS · BILLETS
PIPE · TUBES · WIRE · SPECIAL SECTIONS

UNITED STATES STEEL

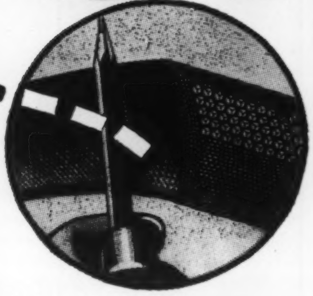

Make this Test with ANY V-Belt

You'll See at Once Why the

CONCAVE SIDE

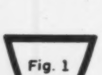
(U.S. Patent No. 1813698)

Saves You Money!

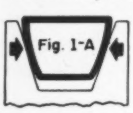


Bend any V-Belt and feel the sides change shape. The top of the belt, under tension, *narrows*. The body, under compression, *widens*. The sides of the belt bulge out.

The result, if the belt is built with *straight sides,* is a shape that does not fit the sheave groove—as shown in Figures 1 and 1A, below.



Straight-Sided V-Belt

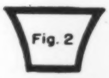


How Straight-Sided V-Belt Bulges in Sheave-Groove

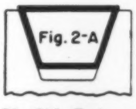
Clearly, the bulging of the sides will produce excessive wear along the *middle* of the sidewall as indicated by arrows.

Now, bend a V-belt with the *concave* side—the Gates Vulco Rope.

You get the same shape change but *now* the new shape exactly fits the sheave groove—as shown in Figures 2 and 2A.

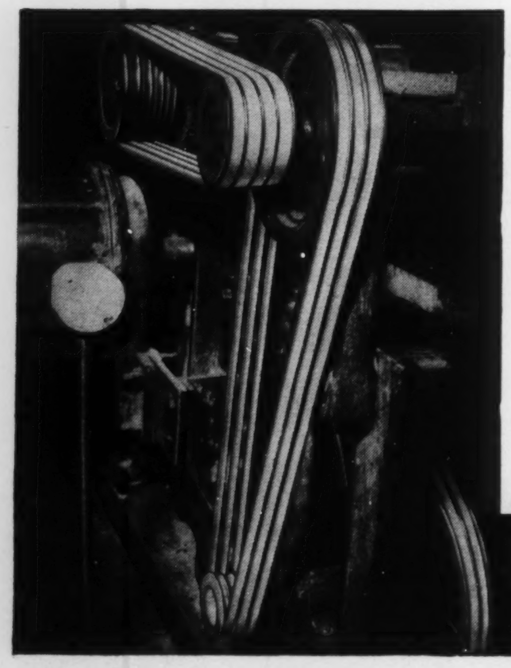


Gates Vulco Rope with Concave Side.



No Side Bulge. Precise Fit in Sheave-Groove.

Results? (1) *Uniform* sidewall wear; *longer life!* (2) Full sidewall grip on the pulley. Carries heavier loads and *sudden load increases* without slippage; saves *belts* and also saves *power!*



The Concave Side is *MORE IMPORTANT NOW* Than Ever Before

Because the *sides* of a V-Belt are what actually *drive* the pulley, it is clear that any increased load on the belt means a heavier load that must be transmitted to the pulley *directly* through the belt's sidewalls.

Now that Gates *SPECIALIZED* Research has made available to you SUPER Vulco Ropes—carrying fully 40% higher horsepower ratings—the life-prolonging Concave Side is naturally more important in conserving belt life today than ever before.

THE GATES RUBBER COMPANY
DENVER, U.S.A.
The World's Largest Makers of V-Belts

494

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The Mark of SPECIALIZED Research

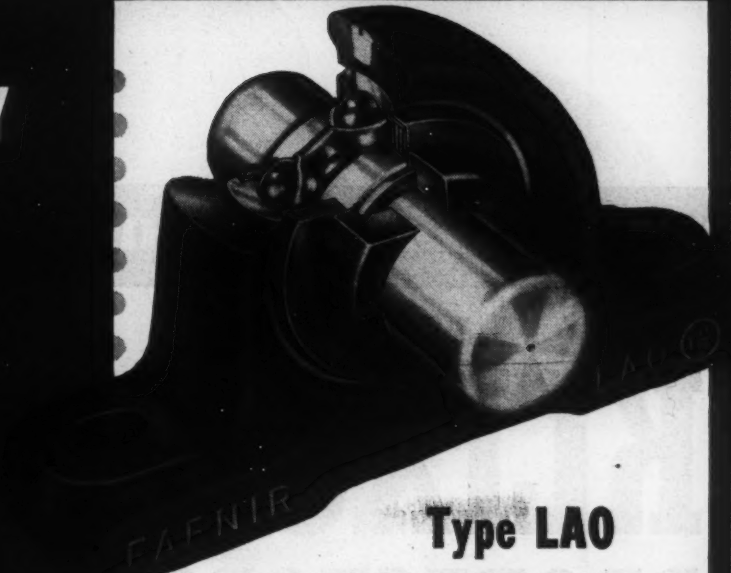
GATES VULCO ROPE **DRIVES**

Engineering Offices and Jobber Stocks IN ALL INDUSTRIAL CENTERS of the U. S. and 71 Foreign Countries

MORE CAPACITY in LESS SPACE

with FAFNIR'S
new line of
heavy duty

PILLOW BLOCKS

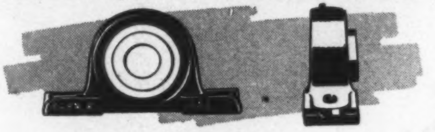


Type LAO

Incorporates the Fafnir Wide Inner Ring Ball Bearing with the exclusive self-locking collar . . . PLUS Mechani-Seals

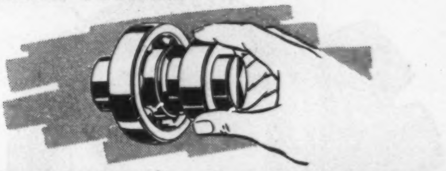
Prelubricated . . . with provision for relubrication. Sizes for 1 3/16" to 2 15/16" shafts.

COMPACT, STREAMLINED DESIGN.

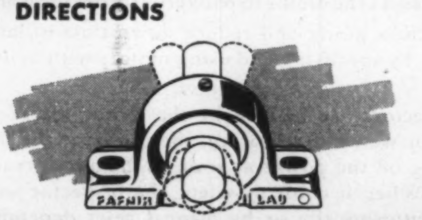


One-piece housing, reinforced at stress points for extra strength. Can be mounted in any position.

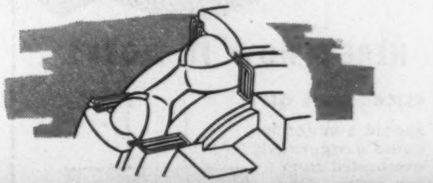
HEAVY SERIES FAFNIR WIDE INNER RING BALL BEARING WITH SELF-LOCKING COLLAR.



UNRESTRICTED SELF-ALIGNMENT IN ALL DIRECTIONS



MECHANI-SEALS PLUS integral synthetic rubber and felt washer. External slinger throws off contaminants.



Not only more capacity in less space but more ball bearing pillow block for the money. Write for full details. The Fafnir Bearing Company, New Britain, Connecticut.

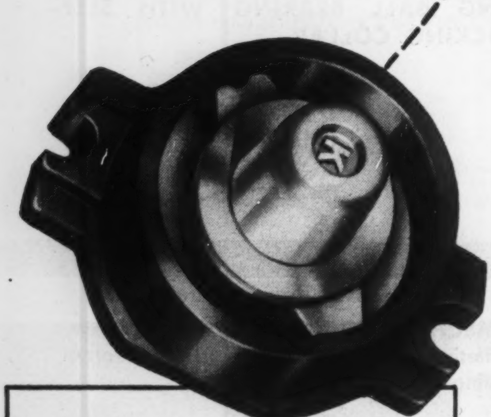
FAFNIR BALL BEARINGS

MOST COMPLETE LINE IN AMERICA

IN MOTORS FOR MACHINE TOOLS

KLIXON PROTECTORS

Keep Equipment Operating by Eliminating Motor Burnouts



One of the major causes of motor burnouts in machine tools is overloading of the machine. This causes the motor to dangerously overheat and burnout.

You can keep production going and reduce down time of lathes, drills, milling machines, etc., by specifying and using motors with built-in Klixon Protectors.

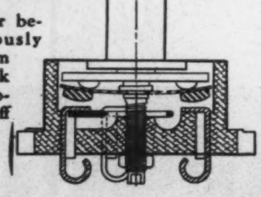
Because Klixon Protectors are built-in by the motor manufacturer and placed where they can watch overheating, they prevent the motor from burning out by cutting off the power as soon as the motor reaches a dangerous temperature. When it cools to safety, the protector snaps on the power again either automatically or by manual reset depending on the type of protector used.

Remember, too, Klixon Protectors prevent burnouts in other equipment such as transformers, solenoids, and adjustable transformers. So to keep your equipment operating, always use motors with Klixon Protectors.

HERE'S HOW IT WORKS

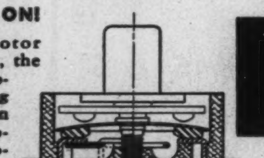
CLICK . . . IT'S OFF!

Should a motor become dangerously overheated from any cause, click the Klixon Protector snaps off the power automatically.



CLICK . . . IT'S ON!

When the motor cools to safety, the circuit is re-established by pressing the red button on the manual protector or automatically when the automatic type is used.

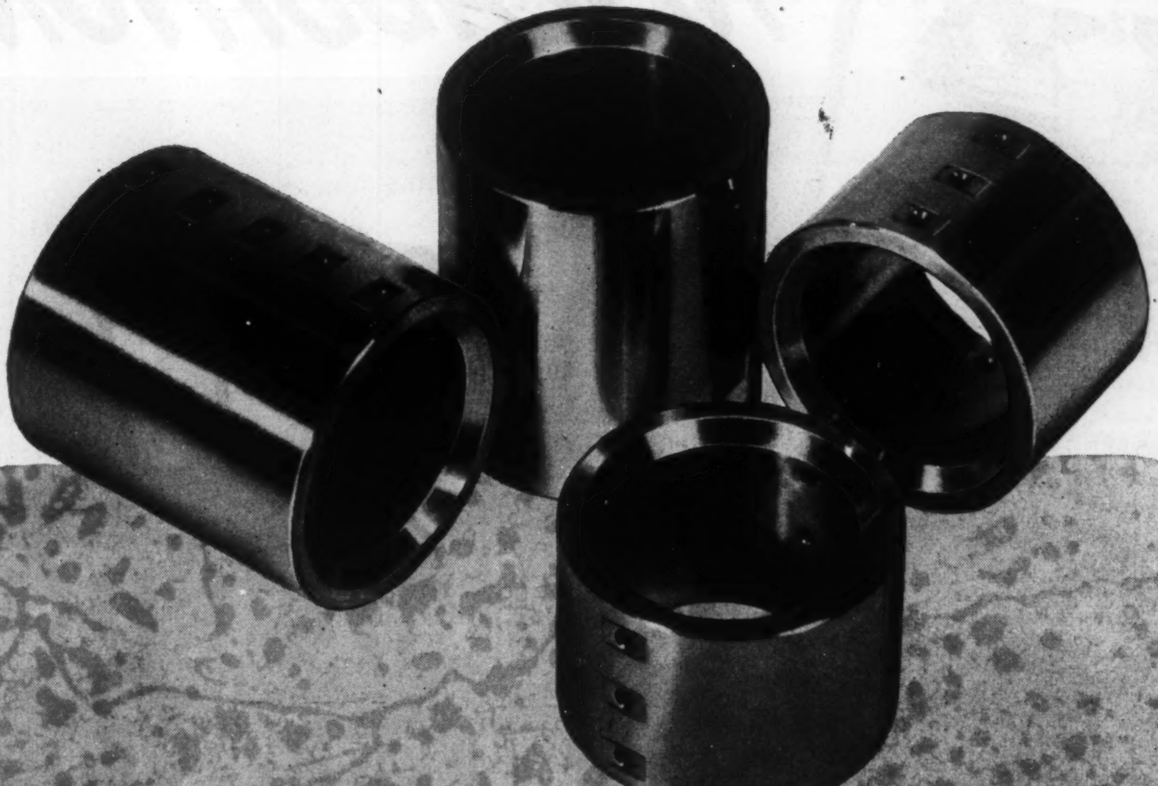


KLIXON

SPENCER THERMOSTAT

DIVISION METALS & CONTROLS CORP.

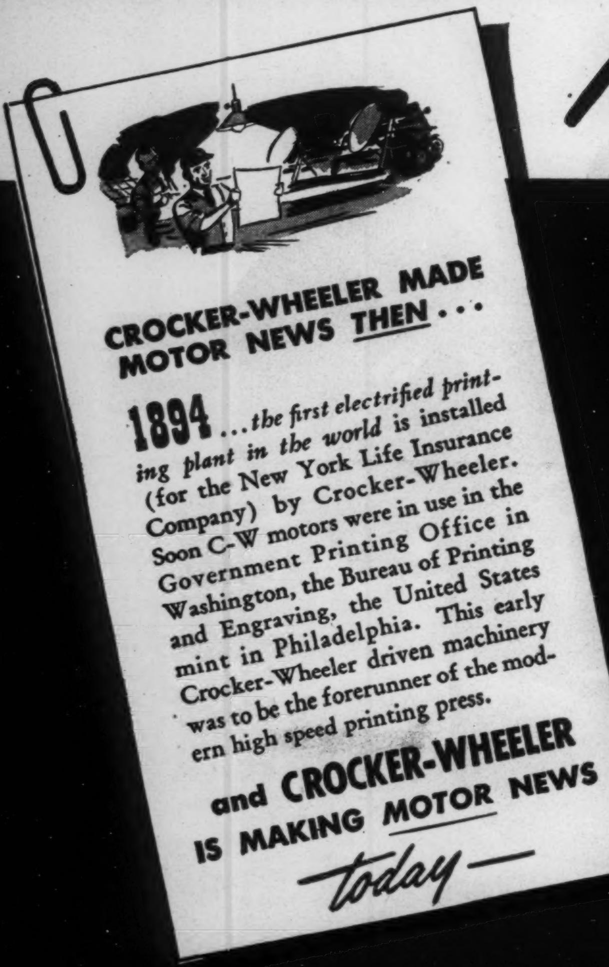
2505 Forest Street, Attleboro, Mass.



Bunting Cast Bronze Bearings lend themselves readily to simple, clean design—only a straight shaft, a bearing of finely finished bearing bronze, a housing surrounding it and the oil film to insulate against noise and wear. The Bunting Brass & Bronze Company, Toledo 9, Ohio. Branches in principal cities.

Bunting®

BRONZE BEARINGS • PRECISION BRONZE BARS • BUSHINGS



CROCKER-WHEELER MADE MOTOR NEWS THEN . . .

1894 . . . *the first electrified printing plant in the world* is installed (for the New York Life Insurance Company) by Crocker-Wheeler. Soon C-W motors were in use in the Government Printing Office in Washington, the Bureau of Printing and Engraving, the United States mint in Philadelphia. This early Crocker-Wheeler driven machinery was to be the forerunner of the modern high speed printing press.

and CROCKER-WHEELER IS MAKING MOTOR NEWS *—today—*

NEW ADDITION

C-W WOUND-ROTOR MOTORS

From 1 to 2000 h.p.

Now Crocker-Wheeler brings you a streamlined Protected-Type WOUND-ROTOR Motor with all the up-to-the-minute advantages of the popular C-W Protected-Type Squirrel-Cage Induction Motors.

Users of C-W Protected-Type Squirrel-Cage Motors know well the advantages of Crocker-Wheeler design . . . and the many mechanical modifications which make these standard motors so versatile. Now the *same* advantages are available in wound-rotor motors.

For printing, conveying, ventilation and other services that require smooth acceleration, high starting torque with low starting current, ability to start and stop or reverse frequently, or variable speed, these new C-W motors will provide unexcelled performance.

Sizes from 1 to 2000 h.p., and an exceptionally wide choice of mechanical modifications, answer practically all application problems. You may have splash-proof and totally-enclosed non-ventilated, as well as the protected-type design. Choose from vertical, NEMA D flange or C face mountings and all standard NEMA floor, or ceiling mounting assemblies. Special windings are available for crane and hoist duty.

The excellence and motor know-how built into C-W Wound-Rotor Motors is clearly explained in the new Bulletin SL-330-1. Mail coupon for your copy. *Now.*

[illegible]

Protected-Type
Induction Motors
Vertical or Horizontal

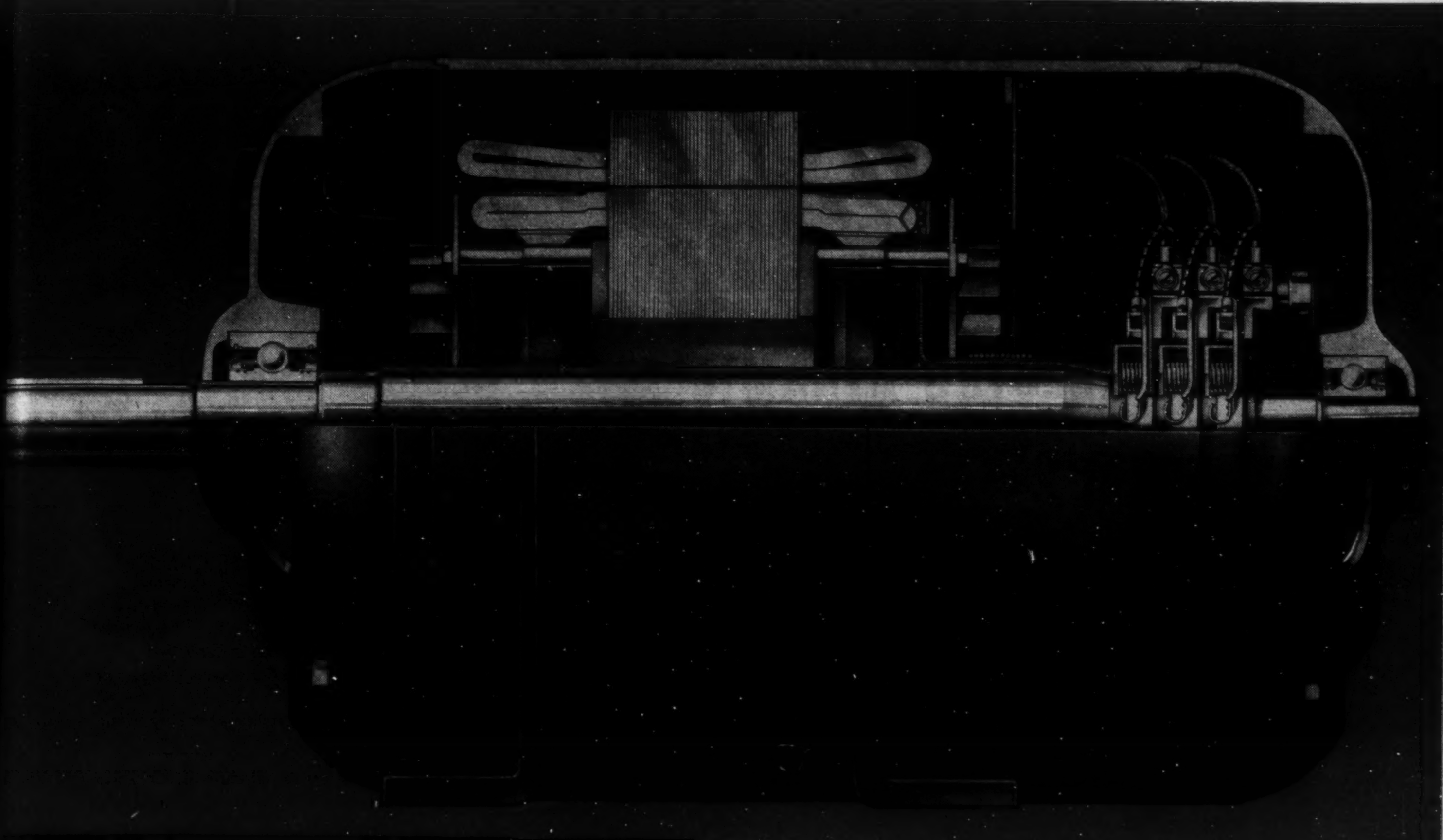
Totally-enclosed,
fan-cooled Motors

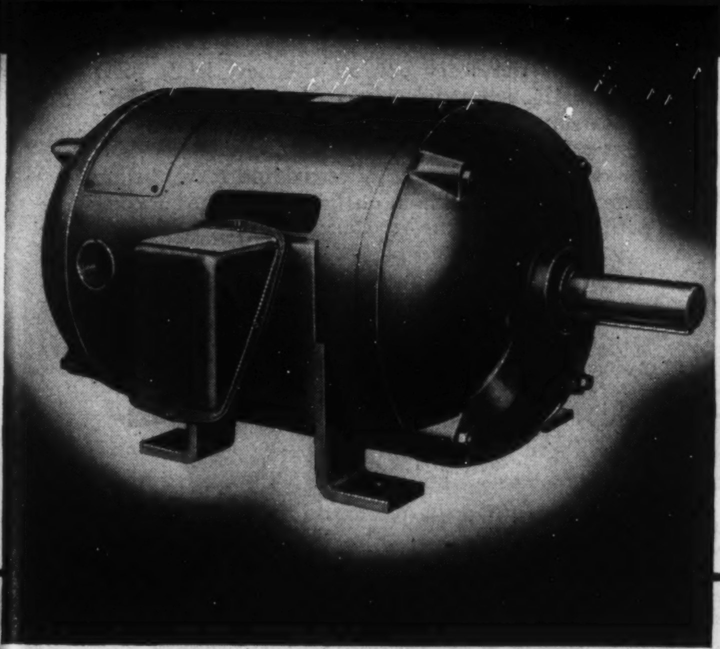
A-C Generators
and High Speed
Synchronous Motors

Large D-C Motors
and Generators

Turbogenerators

to Protected-Type line ----





Better Built because---

Frames and endshields dripproof—keeps dripping liquids and falling chips out of windings.

Louvered openings on both sides of frame for maximum cooling, with effective protection.

Air guides distribute cooling air effectively.

Stator and rotor coils of vinylacetal insulated wire, protected by thoroughly-baked thermosetting varnish for maximum rigidity and long-lasting protection against electrical failure.

Slip rings cast of special composition bronze for long life, mounted on steel hub, insulated from hub by mica sleeve.

NEMA frames 364-505 have heavy rolled steel frame for strength. Sturdy welded feet.

Full details of the many other fine points of these motors are included in the new Bulletin now available. Send coupon.

CROCKER-WHEELER
Wound rotor MOTORS

CROCKER WHEELER

CROCKER-WHEELER AMPERE, N.J. TRADE MARK REG. U.S. PAT. OFF. DIVISION OF JOSHUA HENDY CORPORATION

ELECTRIC MANUFACTURING COMPANY, AMPERE 3, N. J.

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Crocker-Wheeler Electric Mfg. Co.
Ampere 3, N. J.

Please send new Bulletin SL-330-1, describing Crocker-Wheeler Protected-Type Wound-Rotor Motors.

MD—549

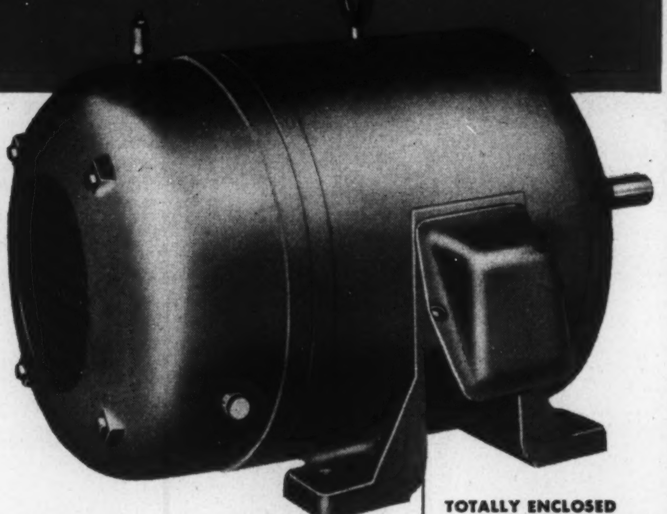
Name..

Title or Function..

Company..

Address..

NO OTHER MOTORS CAN MATCH THIS STAMINA STORY



TOTALLY ENCLOSED
(Fan Cooled)

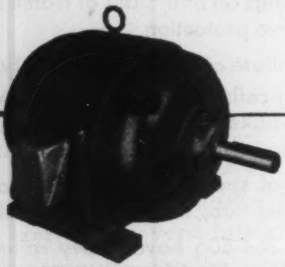
For use in dirt-laden atmospheres, especially where the installation requires a motor of compact dimensions.

How ELECTRO DYNAMIC met a tough challenge with superior WINDINGS

Fifty years ago, when the Electric Boat Company set out to be the world's largest builder of submarines, it determined also to produce the *world's toughest* electric motors (because motor failure on a submarine could mean death to the entire crew). Therefore, in 1899, Electric Boat acquired the Electro Dynamic Company to develop and build these extra-reliable motors.

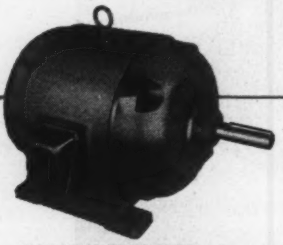
The tremendous increase in the cruising range of the submarine, from a few hundred to *many thousands* of miles, presented a terrific challenge to its electric motors. As a result, Electro Dynamic *windings*—"the heart of the motor"—had to be toughened beyond anything previously conceived, to withstand additional gruelling months of sustained performance. So well did Electro Dynamic meet this challenge that, in addition to submarines, its *stout-hearted* motors have been installed on *over 50% of all American merchant ships* built since the war.

That is the story behind the new ELECTRO DYNAMIC *industrial motors*. Today, the same E.D. craftsmen that achieved greater stamina in marine motors are putting *extra care* and *superior materials* into the Electro Dynamic industrial line. Never before have motors of such high quality been offered at competitive prices! Write for illustrated literature today.



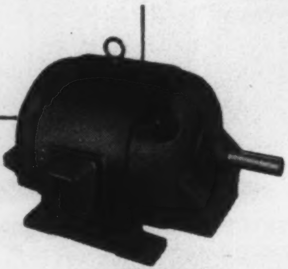
DRIP-PROOF MOTORS

For use under ordinary conditions not requiring protection from splashing liquids or dirt-laden atmosphere.



TOTALLY ENCLOSED
(Non-Ventilated)

For use in exceptionally dirty atmospheres, particularly whe: metallic dust is present.



SPLASH PROOF

For installation where the motor is subjected to splashing liquids or hosing down for cleaning.

Also a Complete Line of DIRECT CURRENT Motors and Generators. Literature on Request.

ELECTRO DYNAMIC

Industry is learning what marine engineers have known since 1880

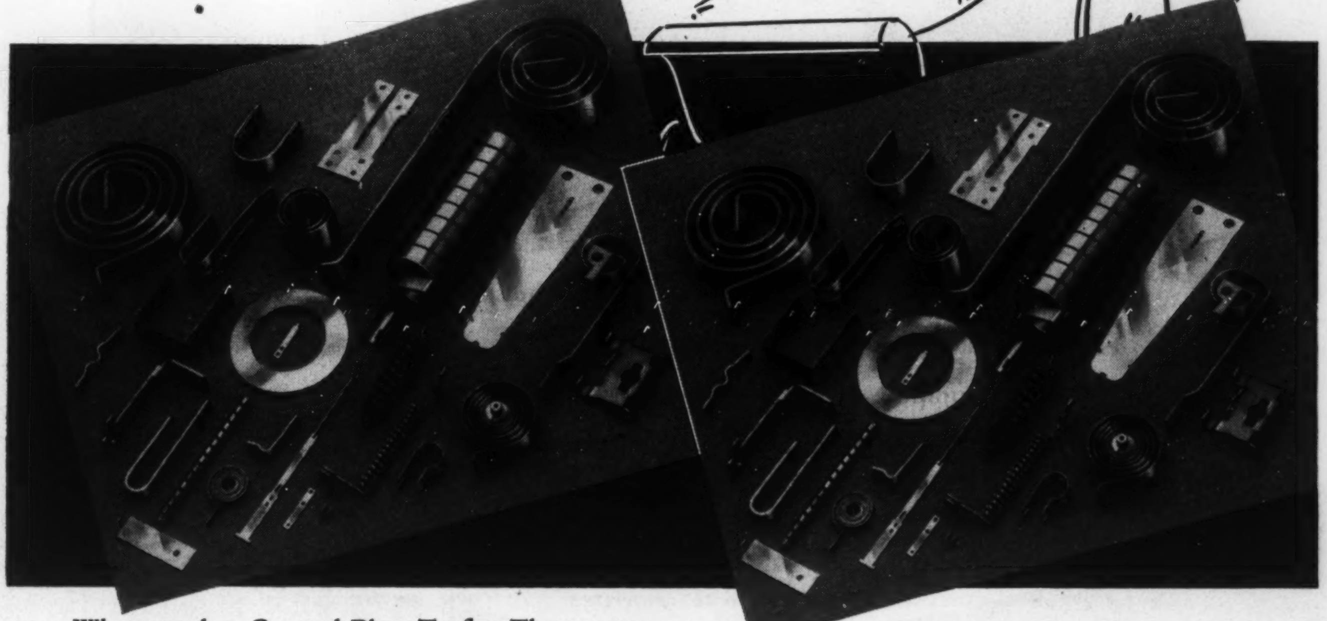
ELECTRO DYNAMIC • Division of the Electric Boat Company • Bayonne, N. J.

Identical Twins...

Born Months Apart

Truflex

THERMOSTAT METALS



When you buy General Plate Truflex Thermostat Metal you can be sure that not only the first lot meets specifications but every succeeding order is a twin . . . has identical characteristics to the original lot . . . whether it be days, months or years apart.

Advanced General Plate production methods insure positive consistency in tolerances, grain structures, expansion, hardness, etc. It assures maximum uniformity of materials which reduces costly rejects and guarantees highest quality performances.

General Plate Truflex Thermostat Metal is available in many types for all temperature requirements. It is made in sheet, strips, coils or in fabricated parts to your specifications ready for installation into your products. Mail coupon for complete information or write for engineering assistance.

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Division of Metals and Controls Corporation

205 FOREST STREET, ATTLEBORO, MASSACHUSETTS

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GENERAL PLATE Division of Metals and Controls Corporation
205 Forest Street, Attleboro, Mass.

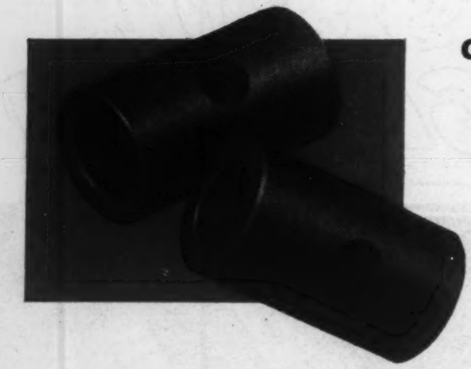
Gentlemen:
Please send me information about Truflex Thermostat Metal.

Name____________________
Title____________________
Firm____________________
Address____________________

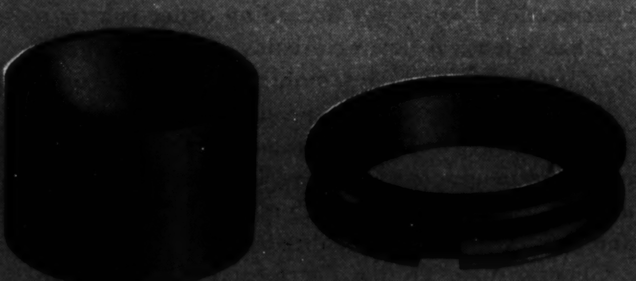
GRAPHITAR BEARINGS

CARBON-GRAPHITE

keep ECO gearless pump operating without lubrication



Graphitar bearings installed at both ends of the main pump shaft are helping the ECO Gearless Pump to operate without maintenance for long periods of time in scores of pumping jobs. ECO Gearless Pumps are designed for operation with gasoline or electric motors to handle a wide range of liquids and viscous fluids. The two Graphitar Bearings permit smooth and quiet operation of the pump, and because they require no lubrication, they eliminate the possibility of contamination by oils or greases of the liquid being pumped. Graphitar bearings operate efficiently at speeds from 300 to 3400 RPM at which the pump shafts are designed to operate.



THE UNITED STATES GRAPHITE COMPANY

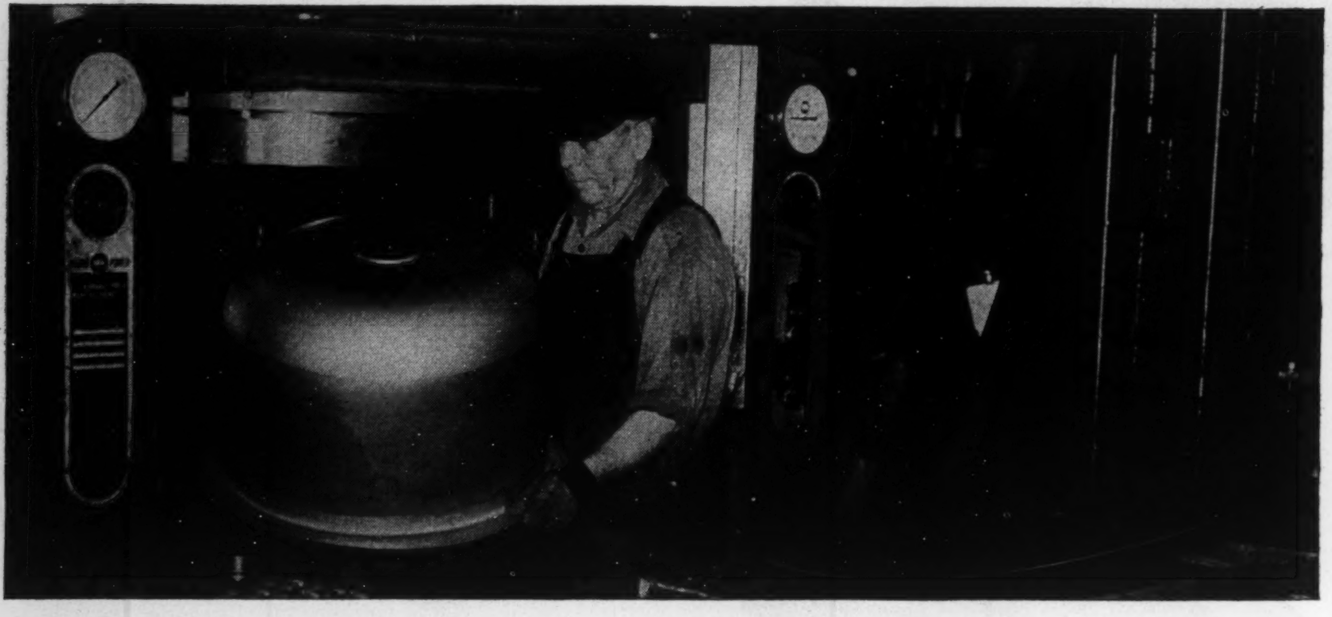
GRAPHITAR

Graphitar has helped scores of manufacturers solve an otherwise difficult manufacturing problem because of its many unique and valuable characteristics. Graphitar is extremely light-weight — lighter than magnesium — yet it is mechanically strong and resistant to wear. Graphitar is chemically inert and unaffected by temperature extremes. It is ideal for seals, rings, pistons, bearings and bushings — it can be produced in any practical size and shape with tolerances as close as .0005″ in small sizes. An inquiry or a sketch of your product will give our engineers an opportunity to show you where Graphitar parts may improve mechanical performance and save you money. We have a catalog which we will gladly send you.

DIVISION OF THE WICKES CORPORATION · SAGINAW, MICHIGAN

Enduro-TURNS IDEAS INTO REALITY!

WASHING MACHINE TUBS OR 500-GALLON KETTLES. Using 40¾" circular blanks of ENDURO Stainless Steel, the 300-ton hydraulic press below forms 21½" inside diameter washing machine tubs in a single 15¾" draw. When the product is too large for drawing—as in a 500-gallon kettle—you can weld formed sections together easily and soundly.



THERE'S SO MUCH YOU CAN DO WITH IT ...AND SO MANY THINGS THAT IT DOES WELL!

Whether you consider it from design or actual production viewpoints, Republic ENDURO Stainless Steel is a most versatile material.

You can fabricate it by every modern method—to practically any desired shape. You can stamp, draw, roll, spin, machine, forge, cast, weld, solder, rivet and otherwise work it. Although certain simple precautions must be taken, you can employ the same equipment used for carbon steels.

On the other hand, there are so many things that ENDURO does well. It greatly simplifies the age-old problem of rust, corrosion and oxidation. Its inherent high strength permits weight saving through the use of thinner sections. It maintains its strength at high or low temperatures. It does not contaminate metallically. It is remarkably easy to clean. Its distinctive beauty encourages unusual decorative treatments. Best of all, it usually costs less in the end.

There are many types of ENDURO—each with specific qualities to do certain tasks well. There is a wide variety of finishes and physical forms to meet all needs. There is literature on ENDURO to help you use and fabricate it to best advantage. Write us.

REPUBLIC STEEL CORPORATION
Alloy Steel Division • Massillon, Ohio
GENERAL OFFICES • CLEVELAND 1, OHIO
Export Department: Chrysler Building, New York 17, N. Y.

Enduro STAINLESS STEEL

REG. U. S. PAT. OFF.

REPUBLIC STEEL

✓ ***Check ALL 12 advantages:*** **• RUST AND CORROSION-RESISTANCE • HEAT-RESISTANCE • HIGH MELTING POINT • LOW COEFFICIENT OF EXPANSION • HIGH STRENGTH • GOOD DIMENSIONAL STABILITY • NO METALLIC CONTAMINATION • EASY TO CLEAN • EASY TO FABRICATE • EYE APPEAL • LONG LIFE • LOW END COST**

STAINLESS STEEL
INDUSTRY EXHIBIT
101
PARK AVENUE
NEW YORK

NATIONAL OIL SEAL LOGBOOK

USE OF DUAL-WIPE "SYNTECH" OIL SEALS

Modern precision machines operate at speeds and temperatures once thought impossible. But the gears and bearings of these "lickety-split" mechanisms still need oil seals to guard against loss of lubricants or damage from external abrasives. Doing this job effectively and safely often requires oil seals as new and specialized as the machines themselves.

Typical of new oil seals developed to meet this challenge are the National 10,000S (Fig. 1) and National 30,000S series (Fig. 2). The 10,000S series is designed for moderate external dust conditions, speeds to 3600 FPM, and temperatures not over 300°F. The 30,000S series is for heavier abrasive conditions, speeds to 2500 FPM, and temperatures not over 300°F.

Both types of seals are used on high speed rear axle and pinion assemblies of modern automobiles and light trucks; on engine crankshafts, power fans, large electric motors and gear boxes of all kinds.

At the pinion "A" in Fig. 3, a National 10,000S seal is used. Its felt outer auxiliary member guards against light dust at the pinion, and can run "dry" at high speeds without injury. The spring-loaded main member, of compounded synthetic rubber, has minimum torque yet retains a pressure head of lubricant with zero leakage.

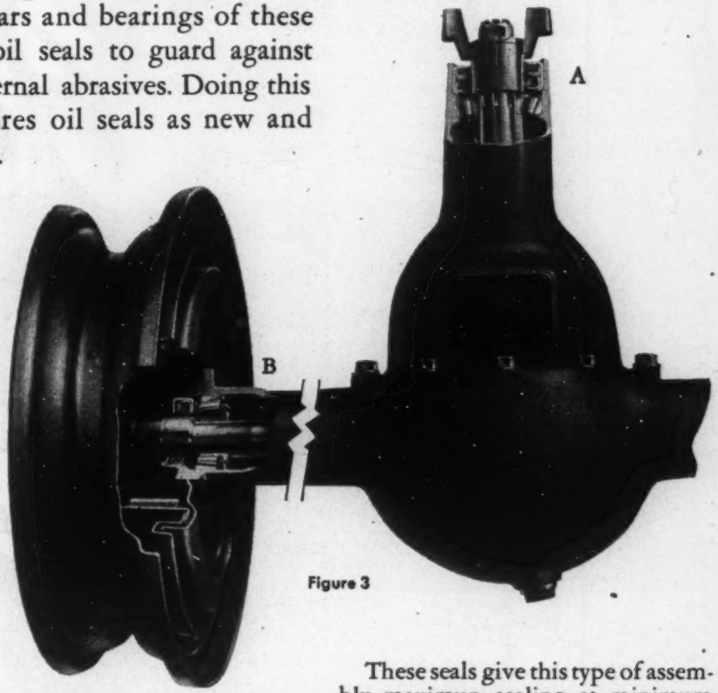


Figure 3

At the wheel position, "B" in Fig. 3, a National 30,000S seal is used. Here speeds do not exceed 800 R.P.M., but absolute "zero leakage" is desired and external abrasives are a constant hazard. This seal employs an accurately spring-loaded synthetic-rubber sealing member to retain bearing lubricant. The outer seal is a rugged leather flange which effectively excludes concentrated dust and dirt.

These seals give this type of assembly maximun sealing at minimum torque—the final goal in every use of the dual seal. Other seal types are available which will solve many specific problems. However, when one or more conditions are unusually extreme, a special seal design may be required.

For more information, contact the National Oil Seal Engineer nearest you or write direct.

NATIONAL
OIL AND FLUID SEALS

NATIONAL MOTOR BEARING CO., INC.

General Offices: Redwood City, California
Plants: Redwood City and Los Angeles, California; Van Wert, Ohio

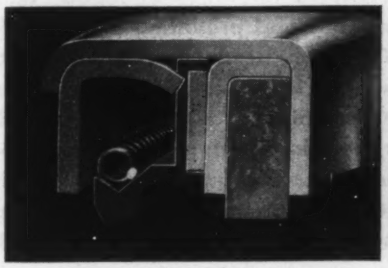


Figure 1

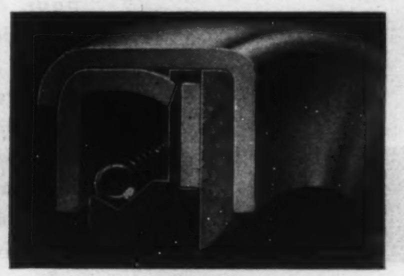


Figure 2

CALL IN A NATIONAL ENGINEER FOR RECOMMENDATIONS

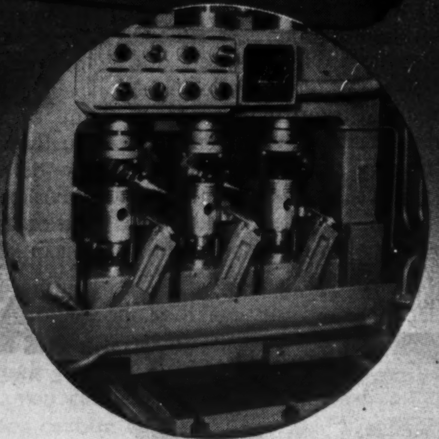
BUFFALO: 56 Arlington Place, Grant 2280.
CHICAGO: Room 2014 Field Building, Central 6-8663.
CLEVELAND: 210 Heights Rockefeller Bldg., Yellowstone 2720.
DALLAS: 30½ Highland Park Village, Justin 8-8453.
DETROIT: Room 1026 Fisher Building, Trinity 1-6363.
HOUSTON: 6731 Harrisburg Boulevard, Wayside 3-1246.
LOS ANGELES: 2244 East 37th Street, Kimball 6384.
MILWAUKEE: 647 West Virginia St., Marquette 8-8986.
NEW YORK CITY: 122 East 42nd Street, Lexington 2-8260.
PHILADELPHIA: 401 North Broad Street, Bell-Walnut 2-6997.
REDWOOD CITY, CALIF.: Broadway and National, Emerson 6-3861.
WEST SPRINGFIELD, MASS.: 1025 Elm Street, Springfield 2-1881.
EAST SYRACUSE, N. Y.: 226 Roby Avenue, East Syracuse 366.
WICHITA: 340 North St. Francis Ave., Wichita 2-6971.

CUT COSTS?

SEE EX-CELL-O!

For Example:

Ex-Cell-O Standard Machine with High Production Fixture—Bores Piston Wrist Pin Holes with .0003″ Tolerance at Net Rate of 211 Pieces per Hour!



To right: Fixture on Ex-Cell-O 112-C Precision Boring Machine provides hydraulic locating and clamping. Operation is tied in with machine cycle. The addition of two interchangeable sets of lower work centers and locating pins adapts the fixture for the whole group of pistons.

The Precision Boring Machine shown to left above (Ex-Cell-O Style 112-C) bores piston wrist pin holes at a rate of 211 pieces per hour, holding a tolerance of .0003″ on the bore diameter, and providing a fine surface finish. The high production fixture accommodates a wide variety of similar pistons. Ex-Cell-O machines like this are also widely used for precision turning, facing and grooving operations. If your production involves parts like this, call your local Ex-Cell-O representative, or write Ex-Cell-O in Detroit today!

EX-CELL-O
CORPORATION
49-9
DETROIT 32, MICHIGAN

XLO
EX-CELL-O for PRECISION

Special Multiple Way-Type Precision Boring Machines • Special Multiple Precision Drilling Machines • Precision Boring, Turning, and Facing Machines and Fixtures • Precision Cylinder Boring Machines • Precision Thread Grinding Machines • Precision Lapping Machines • Precision Broach Sharpening Machines • Other Special Purpose Machines • Tool Grinders • Continental Cutting Tools • Broaches and Broach Fixtures • Counterbore Sets • Grinding Spindles Hydraulic Power Units • Drill Jig Bushings • R.R. Pins and Bushings • Fuel Injection Equipment • Dairy Equipment • Aircraft and Miscellaneous Production Parts

Service Champ AT YOUR SERVICE

MORSE-ROCKFORD

OVER-CENTER

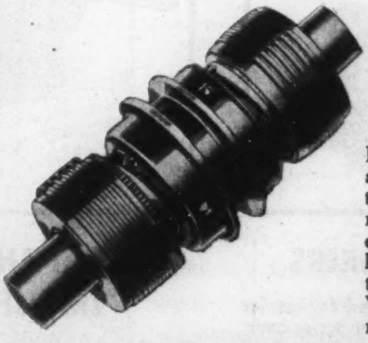
FRICTION CLUTCH

FOR A REAL package of power transmission, here's a small-diameter clutch that offers dependable, powerful, trouble-free operation! It's the Morse-Rockford toggle-type over-center Clutch. The same over-center principle used in high torque, heavy duty tractor and hoisting clutches is found in this compact clutch design.

The Morse-Rockford Clutch's strong, symmetrical body and release sleeve are accurately machined to provide top performance and efficiency. Its operating links, pins, and collars are of hardened steel. The release bearing (shifter collar) is made of the highest quality bronze for long wear and high strength.

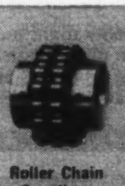
The toggle action of the Morse-Rockford Clutch goes "over-center," locking the clutch in driving position, and provides smooth, easy engagement for powerful pull. The toggles are factory-assembled with the release mechanism and adjusting plate as a unit, assuring easy assembly and disassembly. Adjustment is accomplished by loosening a conveniently located Locking Screw and turning the threaded, forged-steel Adjusting Plate by hand.

Four clutch models, each in three sizes, afford a great variety of arrangements with different driving cups. Morse engineers will make special application recommendations upon receipt of complete information. Catalog SDOC available on request. Write Dept. 355, the Morse Chain Company, Detroit 8, Michigan.



If design space limitations are your problem, check the Morse-Rockford Pullmore Clutch, a multiple-disc clutch transmitting heavy loads in comparison to the clutch diameter. Write for the Morse Pullmore Clutch catalog.

Morflex Couplings



Roller Chain Couplings

Silent Chain Drives

MORSE

MECHANICAL
POWER TRANSMISSION
PRODUCTS

A PRODUCT OF
B-W
BORG-WARNER

Morflex Radial Couplings

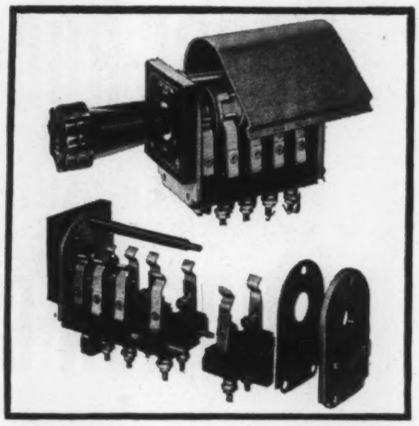
MORSE CHAIN COMPANY • DETROIT 8, MICHIGAN

ALLIS-CHALMERS OFFERS EQUIPMENT

Facts about A-C control

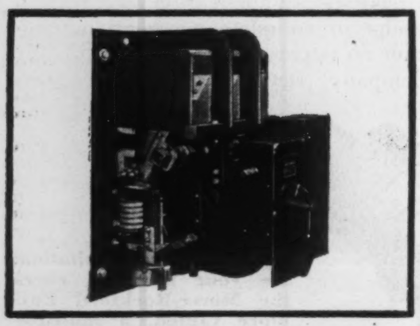
Pictured here is *part* of Allis-Chalmers wide line of switchgear and control devices . . . being advertised for the first time to designers! Now, you can get high quality control devices from the *same* O.E.M. supplier who offers the widest range of V-belt equipment—Texrope—as well as a-c and d-c motors from ½ hp up. For a choice of over 1600 *industry accepted products,* make your headquarters Allis-Chalmers!

Texrope is an Allis-Chalmers trademark



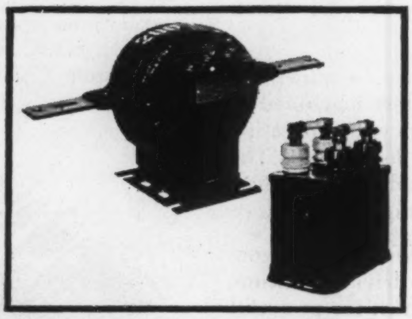
ROTARY CONTROL SWITCHES

Here's a new type rotary control switch especially designed for rough repetitive service. Solid, positive contact motion is achieved through use of square shaft and star-holed contact segments. For ammeter, voltmeter, frequency meter, P. F. meter, circuit breaker, and many other uses. Continuous rating 10 amps, at 600 Volts.



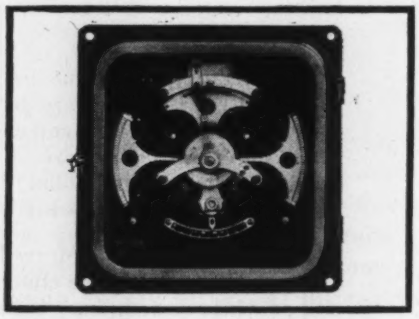
AIR CIRCUIT BREAKERS

Manually or electrically operated for service up to 600 volts a-c. Inverse time series overcurrent trip permits adjustment of overload setting from 100% to 200% of breaker ampere rating, and adjustment of time delay. Also open and enclosed types for individual wall mounting. Type G-25 rated 25,000 RMS amp interrupting capacity; 50 to 600 amp; 600 volts a-c. Type G-50 rated 50,000 RMS amp interrupting capacity; 200 to 1600 amp; 600 volts a-c.



CURRENT AND POTENTIAL TRANSFORMERS

Circular shaped current transformer coils prevent distortion under heavy overcurrents. Flat conductors, accurately formed are hand wrapped with the finest grades of insulating tapes. Construction of potential transformers is compact and strong. Coils are thoroughly impregnated under a vacuum pressure process, insuring a solid coil which is impervious to moisture.



GENERATOR VOLTAGE REGULATORS

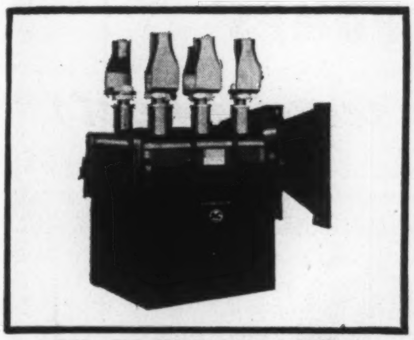
For dependable, smooth, sensitive voltage regulation, you can depend on Allis-Chalmers rocking contact regulators. The principle of *rocking* the field resistance contacts produces smooth, almost frictionless resistance changes. Because of only slight mechanical movement, response is quick with very little bearing wear. Eight type sizes are available for control of a-c and d-c generators of all ratings.

Pioneers in Power and Electrical Equipment
From Generation Through Utilization

ALLIS-

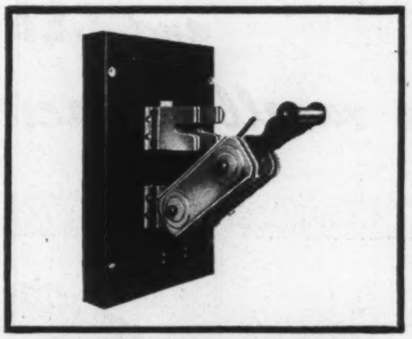
AID TO ELECTRICAL DESIGNERS!

and switchgear devices



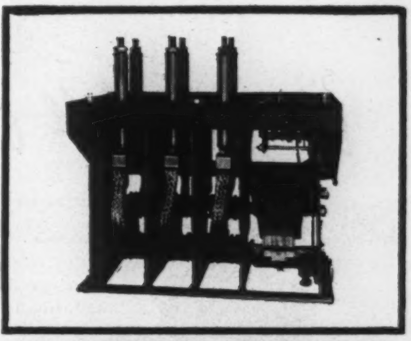
OIL CIRCUIT BREAKERS

Designed for control and protection of generators, feeder circuits, and transformer banks. Available in fully automatic, or non-automatic; manually or electrically operated. Ratings from 15,000 to 50,000 kva interrupting capacity; up to 7500 volts and 1200 amps. Also available are special oil circuit breakers for use in auto transformer circuits of large motor starters; manually operated.



DISCONNECT SWITCHES

Hook stick operated switches rated up to 2000 amp for either panel or framework mounting. Five thousand to 15,000 volts; 600, 1200, and 2000 amps. Also heavy duty clamp type switches for higher load concentrations. Available in panel mounting or unmounted, manual or hook stick operated. Up to 600 volts a-c; 3000 to 6000 amp; 750 volts d-c; 2000 to 10000 amp.



OIL IMMERSED CONTACTORS

Designed for heavy duty motor starting in industrial plants. Contact pitting is reduced by means of improved contact mechanism in which moving contact wipes and rolls with each operation. For use on full and reduced voltage squirrel cage and synchronous motor starters. Maximum ratings 200 amp; 1500 hp at 2300 volts. Interrupting ratings — 10 times full load motor current.

START
STOP
START
STOP

PUSH BUTTON STATIONS

Functional design plus pleasing appearance make these push button stations ideal for almost any industrial use. Available in light duty surface mounting, and heavy duty flush or surface mounting in hundreds of combinations. Ratings up to 600 volts a-c maximum.

All start buttons are encased in shrouds to prevent accidental starting, and locking bars are available so that buttons can be locked in the "stop" position. Delivery from stock.

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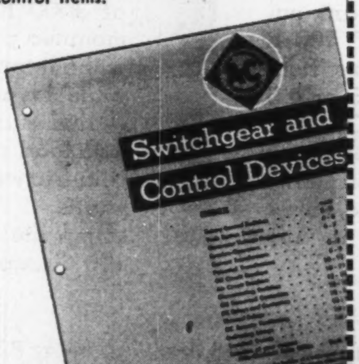
for new 16 page bulletin 25B7095 covering Allis-Chalmers switchgear and control devices. It's filled with useful engineering information, including ratings and capacities. Illustrates over 75 control items.



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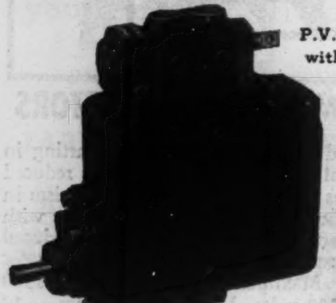
CHALMERS

HYDRECO

SMALL SIZE—SMALL VOLUME OIL HYDRAULIC COMBINATIONS *and* GEAR PUMPS

fill the bill for small capacity requirements

P.V.T. COMBINATIONS

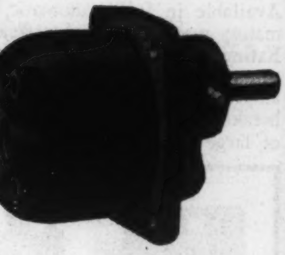

P.V.T. 100 Group with small tank

P.V.T. 100 Group with large tank

Complete units requiring one mounting, include pump, tank, control valve and relief valve. Two types, P.V.T. 100 A with tank capacity of 95 cubic inches and P.V.T. 100 B with tank capacity of 190 cubic inches. Both combinations available in either 2.25 or 4.5 G.P.M. capacity at 3000 R.P.M. at 1000 P.S.I. Pump furnished with rotation in either clockwise or counter clockwise direction. One plunger or two plunger valve available, either single-acting or double-acting and in any sequence. Built-in relief valve.

100 SERIES GEAR PUMPS

Foot Mounted Pump


Flange Mounted Pump

The 100 Series HYDRECO pump is available in two capacities, 2.25 or 4.5 G.P.M. at 3000 R.P.M. at 1000 P.S.I. as a flange mounted pump or foot mounted pump with or without pulley. Pump has maximum resistance to adverse operating conditions . . . sealed outboard bearing on drive shaft takes side load pressure when pulley operated . . . anti-friction bearings on both drive and driven shafts . . . bronze wear plates for increased pump life. These pumps are used on P.V.T. 100 Group combinations.

Send for folders giving detailed specifications on P.V.T. 100 Group combinations and 100 Series HYDRECO oil hydraulic gear pumps.

HYDRECO

HYDRAULIC CONTROL DEVICES

PUMPS CYLINDERS VALVES

HYDRAULIC EQUIPMENT COMPANY 1106 EAST 222nd STREET • CLEVELAND 17, OHIO

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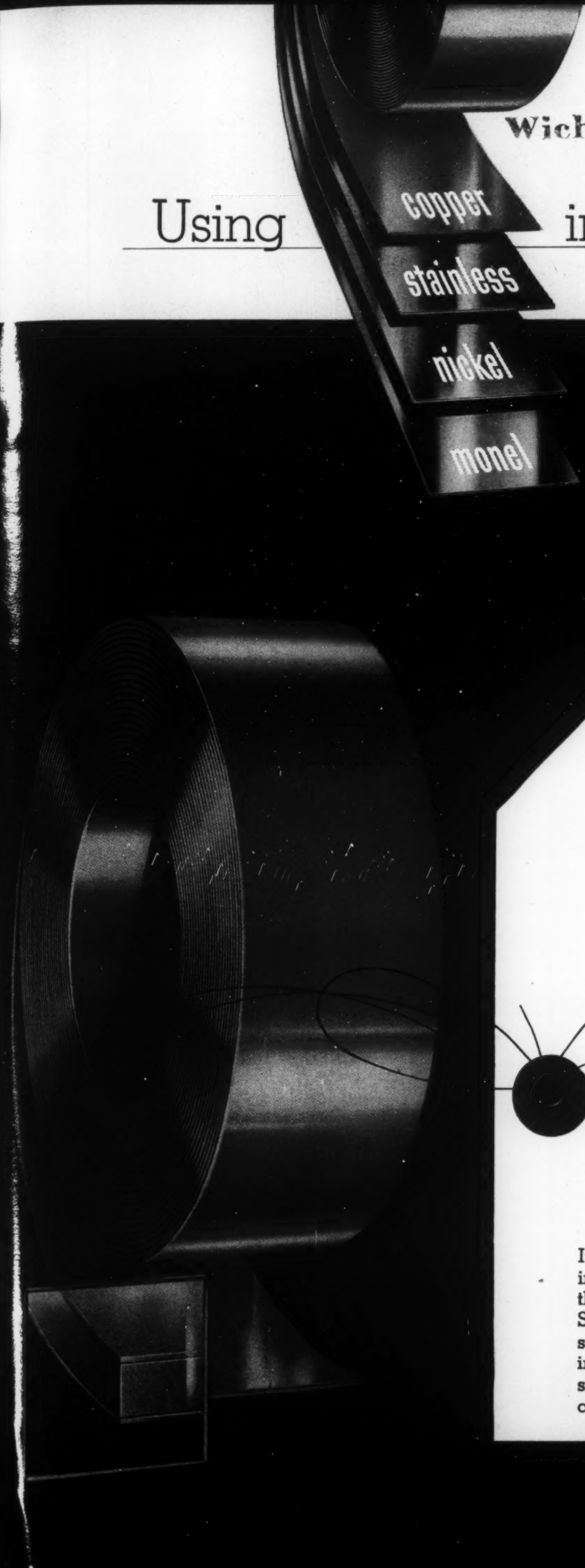
Using copper stainless nickel monel in your product?



where you need only the

solid surface

—that's all you need to buy!

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CLAD METALS

If you don't use the "inside" of the gauge thickness in your applications for expensive-metals strip, have the core of plain steel—and save money! With SuVeneer Clad Metals, you get the dense, solid surface of stainless, copper, nickel or monel, bonded inseparably to low carbon strip steel on one or both sides. You get the *performance* you need, at lower cost. ● *Write for the detailed facts.*

Superior Steel
CORPORATION
CARNEGIE, PENNSYLVANIA

SNAP-LOCK
TRADE MARK
LIMIT SWITCH

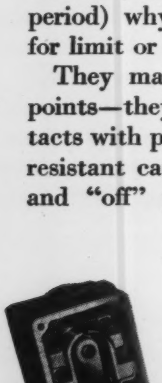
SNAP-LOCK
LIMIT SWITCH
16D-120
THE NATIONAL ACME CO.
CLEVELAND, OHIO
MADE IN U.S.A.

...More Than Mere Snap Action

There's a real *difference*—ask any one of the several thousand satisfied customers who've bought Snap-Lock limit switches from us in the past ten years. Better still, ask one of our *new* customers (and we recently counted 75 in a 30-day period) why they specified Snap-Lock, whether for limit or our other types of switches.

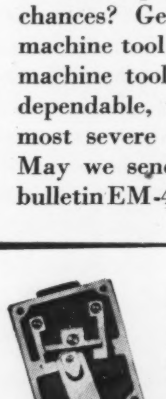
They may not go into detail on the design points—they may skip over the pure silver contacts with positive wiping action, the oil and dust resistant case, the locking action for both "on" and "off" positions, the completely separated mechanical and electrical sections—but they'll all tell you the Snap-Lock can *take it.*

A good limit switch is the mighty midget on your machine. It costs only a few dollars, but controls equipment worth thousands. Why take chances? Get the *only* switch that's built by machine tool builders, for the kind of punishment machine tool usage dishes out. When you want dependable, trouble-free performance under the most severe conditions, you'll want Snap-Lock. May we send you more information? Write for bulletin EM-42, showing different types of switches.



Electrical Features

Snap! and the circuit is closed—or opened. Pure silver contacts. Positive wiping action—with no arcing. Wiring connections easily accessible. Insulation in excess of specification requirements. Oil and dust resistant case. Single pole, double break, double throw.



Mechanical Features

Locks in ON or OFF position. Rugged construction; completely separated from the electrical section. Operates on light pressure at 10° travel with additional 29° over-travel. Standard operating lever of drop-forged steel, equipped with hardened steel roller. Stainless steel shaft running in bronze bearing.

The NATIONAL ACME CO.

180 EAST 131st STREET • CLEVELAND 8, OHIO

Acme-Gridley Bar and Chucking Automatics: 1-4-6 and 8 Spindle • Hydraulic Thread Rolling Machines • Automatic Threading Dies and Taps • The Chronolog-Limit, Motor Starter and Control Station Switches • Solenoids Centrifuges • Contract Manufacturing

Centrifugal forces over

250,000 times gravity

...are attained by this
EEMCo -powered
ultracentrifuge
a Special
EEMCo Motor
for a Special Duty
"spinco"
ultracentrifuge for
medical and biochemical
laboratories

The terrific centrifugal forces, precision control, and utmost dependability required in operation of this fine laboratory device dictated special motor requirements. *EEMCO* engineers developed this special motor application to provide a powerful precision-speed-controlled electric drive capable of hundreds of hours of high speed operation without attention. The 1-1/2 hp motor operates on 110-volt current, AC or DC, at 12,000 rpm. It is both air and water cooled.

The manufacturers of the *"Spinco"* Ultracentrifuge, *Specialized Instruments Corporation,* Belmont, Calif., called on *EEMCO* for services typical of special motor development and manufacture performed by *EEMCO* for leading companies in diverse lines throughout the nation. *EEMCO* has solved the widely varying electric drive problems of manufacturers of ultrasonic sound generators, oil well recovery tools, power saws, radar equipment, submersible pumping units, aircraft, and dairy homogenizers.

EEMCO-designed motors and drive units have solved the very toughest problems of function, power, size, weight, shape, performance, installation and operation.

for YOUR
motor
problem
up to
EEMCo

Perhaps you need a completely special design...or we may be able to adapt a basic *EEMCO* design to meet your needs. Let *EEMCO* tackle *your* motor problem.

ELECTRICAL ENGINEERING and MFG. CORP.
4606 West Jefferson Blvd., Los Angeles 16, California

EEMCo

SPECIAL MOTOR DESIGN DEVELOPMENT MANUFACTURING

FOR ENGINES OF
5 HORSEPOWER OR LESS
Specify
THE NEW ZENITH

"WORKHORSE"

A Thoroughbred

THROUGH and THROUGH..........Because it's Built by

ZENITH

40 years' experience in specialized carburetion

- **High angularity design**
- **Adjustable high speed control**
- **Reasonably priced**
- **Flexible through wide range of applications**
- **Adjustable idling control**
- **May be balanced so the air cleaner has a minimum influence on fuel-air ratio**

Strict adherence to the highest standards of quality and performance through 40 years of experience have made Zenith* the undisputed leader in the field of heavy-duty carburetion. Now, Zenith has incorporated these same characteristics into the "Workhorse", a compact, lightweight carburetor ideally suited for engines of 5 horsepower or less. Its high angularity design assures dependable operation even when severely slanted. Simplicity of installation, easy maintenance and reliable performance make it a real "Workhorse". And because it is made by Zenith, you know it is a thoroughbred through and through.

*REG. U. S. PAT. OFF.

ZENITH CARBURETOR DIVISION of Bendix AVIATION CORPORATION
696 HART AVENUE • DETROIT 14, MICHIGAN
MANUFACTURERS OF FINE CARBURETORS AND FUEL FILTERS

How many of these packing installations can you identify?

All of them depend on Houghton Packings

Every reader will recognize the conventional machine designs pictured above, but some of the hydraulic devices may be difficult to identify in these small reproductions.

We'd like to offer a prize to those who can correctly name all of these types of hydraulic mechanisms—but we'll resist the temptation. If you'd like a complete list of the installations pictured above, write us.

Of course, we should rather have you write for details or recommendations on some hydraulic packing job on which you are now working. You no doubt know that Houghton, pioneer in packings, supplies all types and styles of hydraulic and pneumatic packings, including both leather and synthetic rubber—fabricated, homogenous and "O" rings. We're neutral, will suggest the best type of packing for the job. Won't you write us? E. F. Houghton & Co., Philadelphia 33 and all principal cities.

HOUGHTON'S
VIM LEATHER and VIX-SYN PACKINGS

SHAVING ASSURES BETTER GEARS AT A GREATER OVER-ALL *Production Economy*

This gear shaving machine, the first of its kind, was introduced 16 years ago to fulfill the urgent need of gear manufacturers for a means of correcting precision gears and gears produced to operate under critical loads and speeds—these corrections to bring them within required tolerances.

Today, it is being used by all the leading manufacturers in the automotive industry, the majority of gear jobbing shops and nearly all the machine tool builders.

One gear manufacturer says shaving has reduced rejects which formerly amounted to about 50% to none. Another says that shaved gears have cut operating power requirements approximately 20%.

Gear shaving eliminates the need for skilled machinists, regardless of the degree of precision required. Accuracy does not depend on the shaving machine operator. Shaving also makes it easier to turn out acceptable gears. The teeth of shaved gears have uniform accuracy and the characteristics of all the gears in any lot will be uniform.

Write for descriptive literature.

SPUR AND HELICAL
GEAR SPECIALISTS
ORIGINATORS OF ROTARY SHAVING
AND ELLIPTOID TOOTH FORM

NATIONAL BROACH AND MACHINE CO.

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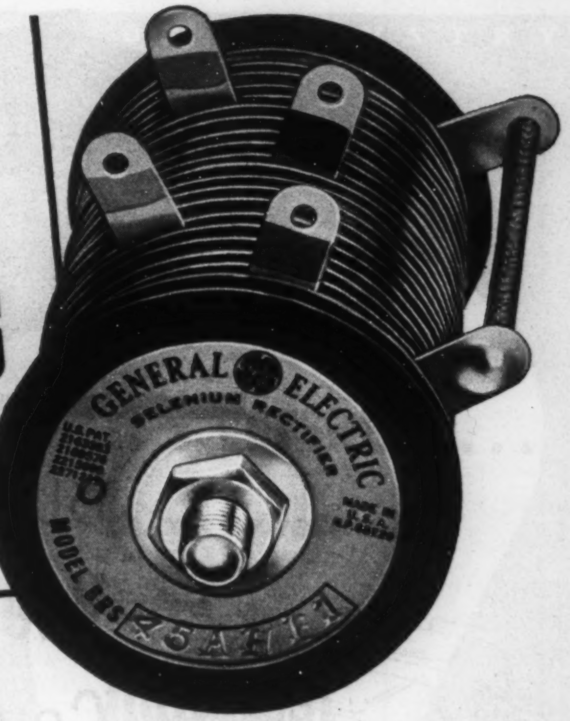
WORLD'S LARGEST PRODUCER OF GEAR SHAVING EQUIPMENT

# *Now..higher voltage*
from
GENERAL ELECTRIC
SELENIUM STACKS
using
NEW 18-VOLT (D-C) CELLS



New process for depositing selenium means greater uniformity, higher efficiency and longer useful life for rectifier stacks.

Here's real news for rectifier users. It's the new G-E 18-volt selenium cell—made by a patented evaporation process which deposits selenium on the aluminum base with greater uniformity than otherwise possible.

Greater Output — These new cells have a 50 per cent greater output than standard 12-volt cells. And—they can be used for any application except those few which demand 24-hour year-around service.

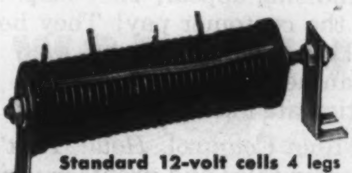
Efficiency Stays Up — Not only is initial efficiency higher but, with the more uniform coating, high efficiency is maintained.

Save Space — These new 18-volt cells require about one-quarter less space than standard 12-volt cells for the same output.

Lower Cost — Depending on the voltage, these 18-volt cells save 25 per cent in cost compared to standard 12-volt cells.

You'll need more information. There's a free bulletin awaiting you. Ask for it as GEA-5280, *Apparatus Dept., General Electric Company, Schenectady 5, N. Y.*

HERE'S A COMPARISON—full-wave bridge rectifiers



Standard 12-volt cells 4 legs of 7 cells each makes a 28-cell stack rated at 84 volts output (and usable at 90)

New 18-volt cells 4 legs of 5 cells each makes a 20-cell stack rated at 90 volts output.

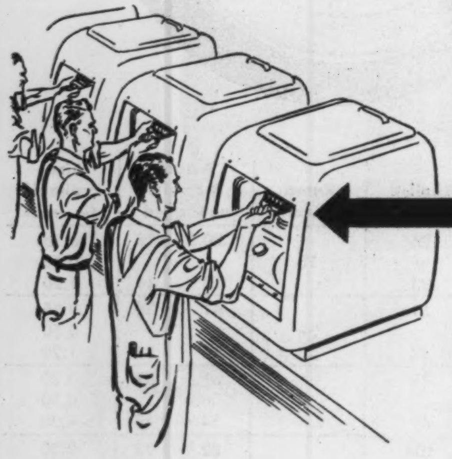
Applied a-c volts	Rated d-c volts	Actual d-c volts		Size available d-c amps
		new	aged	
26	18	20.5	18	0.25
				0.50
23		18	16	1.20
52	36	41	36	0.25
				0.50
46		36	32	1.20
78	54	61.5	54	0.20
				0.50
69		54	48	1.00
104	72	82	72	0.20
				0.50
92		72	64	1.00
130	90	102.5	90	0.20
				0.40
115		90	80	1.00
156	108	123	108	0.20
				0.40
138		108	96	0.80
182	126	143.5	126	0.15
				0.35
161		126	112	0.80

The d-c voltages are given for both new and estimated aged conditions. On applications where a variation in d-c voltage can be tolerated, a fixed a-c voltage can be applied—a gradual decrease in d-c voltage, as given in the third column, can be expected. On applications requiring constant d-c voltage, it will be necessary to adjust the voltage of the a-c input—the range given in the first column will give the rated d-c output shown in the second column.

GENERAL ELECTRIC

456-10

Build-in **Veeder-Root** Counters



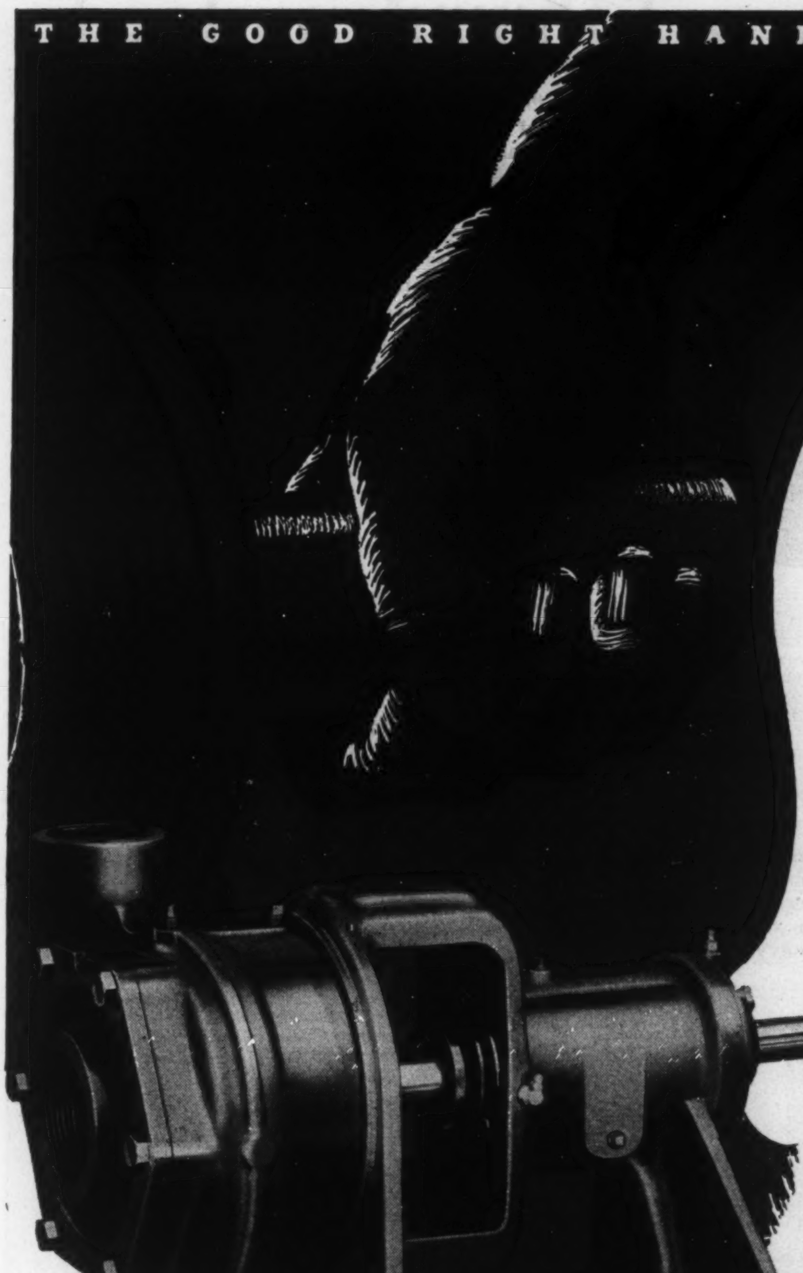
and Build Up Your Product's Sales!

Veeder-Root Counters can be *engineered into the design* of almost all types of machines, from addressing to vending. These counters do countless things, depending on the application and its peculiar requirements. They add new usefulness to a product—new merchandising appeal. They help prove the product's service guarantee, sometimes even help the customer pay! They help prevent errors, delays, shortages, overruns, waste, danger. They help provide an equitable basis for wage payment and incentives. Or they can help to co-ordinate production and work-schedules more closely—as well as anticipate maintenance needs. Those are a few of the jobs being done every day by Veeder-Root *Count*rol. *How?* That's for us to tell *you!* So if you want to count your way to greater sales and profits—*write.*

VEEDER-ROOT INCORPORATED, HARTFORD 2, CONNECTICUT
In Canada: Veeder-Root of Canada, Ltd., 955 St. James St., Montreal 3.
In Great Britain: Veeder-Root Ltd., Kilspindie Rd., Dundee, Scotland.

Veeder-Root COUNTERS

THE GOOD RIGHT HAND OF INDUSTRY



It's Versatile . . .

takes whatever drive is

handiest

Meet the "any-drive" pump—the new Worthington CN many-purpose Centrifugal that can be driven by the most convenient means available.

It's another general utility pump like the famous Monobloc—but without the motor. The liquid end is mounted on a frame, from which the shaft extends to be coupled to a motor, fitted with V-belt sheave, or what have you. In an emergency, you can quickly shift to another type of drive.

It's *rugged*—designed for overhung pulley-drive—rigid shaft maintains perfect alignment of pump parts. It's *flexible*—use interchangeably either packed stuffing box or mechanical seal.

More Pumps "Across the Board"

Worthington makes all types, all sizes of standard pumps. When you reach the point of specifying a pump for your equipment, remember that no company offers more pumps—no company offers more value in pumps—than Worthington. Send coupon for free bulletin showing why, in pumps, *there's more worth in Worthington.*

Worthington CN Centrifugal Pump—its short oversize shaft means better service, longer life.

WORTHINGTON

MERCHANDISING DIVISION

The Good Right Hand of Industry

POWER TRANSMISSION: sheaves, V-belts, variable speed drives

PUMPS: centrifugal, power, rotary, steam

COMPRESSORS: horizontal, radial, vertical

Worthington Pump and Machinery Corp.
Merchandising Division, Dept. A89
Harrison, New Jersey

☐ Send latest bulletin on Worthington Centrifugal Pumps. Any other (type)........

Name..............................

Company..............................

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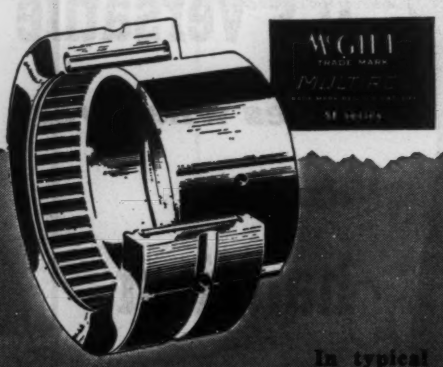
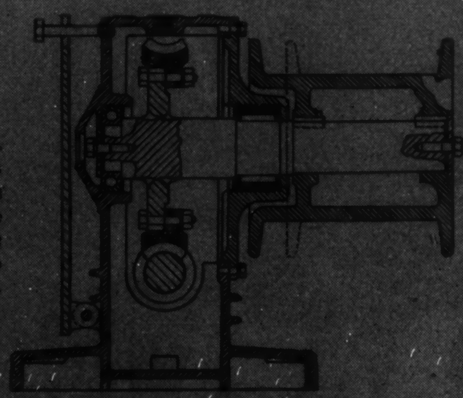
design anti-friction efficiency into out-moded plain bearing applications

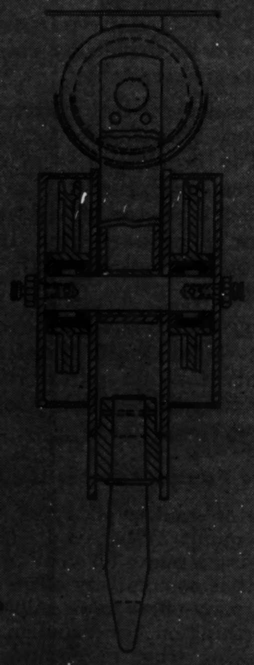
THE MULTIROL WAY

When design demands maximum load capacity in limited space . . . plus top anti-friction performance . . . get results with MULTIROL SE Series full type roller bearings. MULTIROL SE Series bearings afford definite performance advantages over friction bound plain bearings. They increase machine efficiency with the kind of smooth precision operation that requires less maintenance for longer machine life — power requirements are less for MULTIROL bearing equipped machinery. SE Series construction is simplified . . . no loose or welded in roller retaining washers . . . lubrication reservoir built in. Smaller radial bearing space with increased load capacity permits more compact and less expensive housing facilities. All add up to improved anti-friction performance. Use with or without inner race in shaft sizes from ⅜" to 9¼". Write for data now!

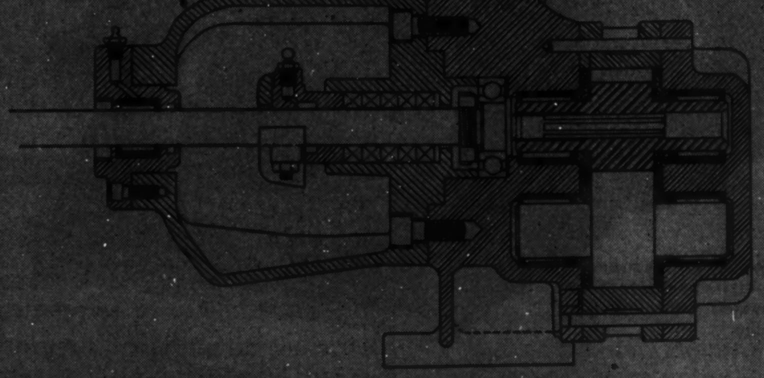




In typical capstan application MULTIROL SE Series maximum capacity bearings fit the small space under the cable drum, yet accept large diameter shaft necessary to carry heavy overhung load.



Use MULTIROL SE Series bearings on sheaves for maximum shaft diameter of pin and minimum housing OD . . . increases load capacity. Lubrication with Alemite fittings need less care than oil bath with plain bearings.



On a rotary gear pump, the heavier load capacity and comparatively small OD of SE Series MULTIROL Bearings permits use of larger shaft that resists deflection. Precision anti-friction requires less power input.

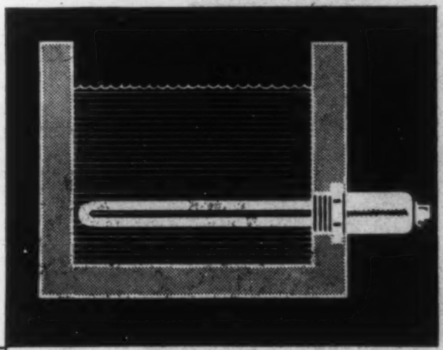
Interested in SE Series MULTIROL bearing advantages? Write today for your copy of Bulletin SE-48. McGill Manufacturing Co., Inc. 200 N. Campbell St., Valparaiso, Indiana

McGILL
TRADE MARK
precision bearings

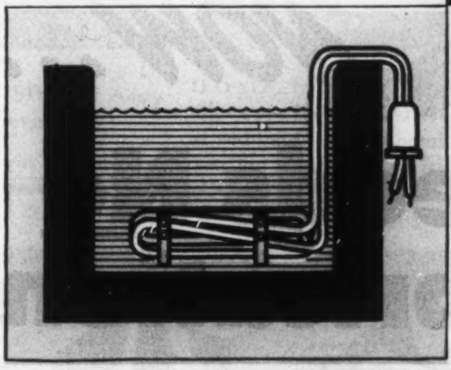
heating liquids?

For greater heating efficiency with minimum heat losses...

Specify General Electric *Calrod** HEATERS

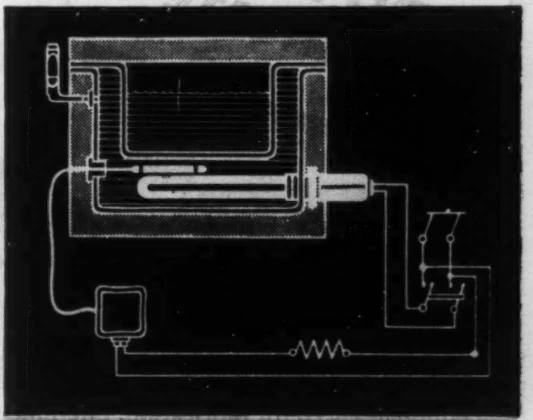


◀ **"SCREW-IN" TYPE** Calrod immersion heaters are real, compact space-savers. Mounted through the side or bottom of the liquid containers, they give you *direct placement* of the heat source . . . right into the liquid. Available in many sheath materials, you can get these Calrod heaters in ratings from .6 to 10 kw or more.



◀ **"OVER-THE-SIDE" TYPE** Calrod immersion heaters are readily portable, easily removed for cleaning, and are particularly suitable for use with rubber or lead-lined tanks; tanks of wood, slate, and other materials not readily adaptable to heaters with threaded headers. These heaters come in a wide variety of sheath materials and formations in ratings from 2 to 6 kw or more.

"JACKETED" CONSTRUCTION is used when ▶ liquids do not permit direct immersion of the heaters. Carbonizing of highly viscous materials and "boiling-out" of solvents in certain compounds is prevented by temperature control equipment. Steam-jackets are used where higher temperatures and quicker transfer of heat is desired.



*Reg. U.S. Pat. Off.

Water
Oils
Chemical Baths
Plating Solutions
Alkaline Solutions
Cleaning Compounds
Heat-Transfer Materials

For your **FREE COPY** of the new, idea-packed, application bulletin, "Heating Liquids," clip this coupon and mail today.

GENERAL ELECTRIC

Apparatus Dept., Sect. A720-2
General Electric Co., Schenectady 5, N. Y.

Please send my free copy of GEA-5077 for

Name..............................

Company..............................

Address..............................

City.................... **State**..........

YOU CAN BE **SURE**.. IF IT'S

Westinghouse

up to 1/3 less space...
improved windings...
plate steel protected...
WESTINGHOUSE
DO NOT LUBRICATE

—and NOW...

Needs No Lubrication

Now . . . for the first time . . . you can install electric motors, or motor-driven machines . . . and forget motor lubrication.

Westinghouse Life-Line . . . industry's amazing, new, all-steel motor . . . now completely eliminates need for lubrication. Life-Line motors are equipped with sealed bearings, pre-lubricated with a more-than-ample supply of specially treated lubricant. Correct lubrication is assured . . . machine outages are reduced . . . motor-drive problems are simplified, since motors can be located without need for constant accessibility.

Added to Life-Line's plate-steel protection, improved windings and more compact size, *pre-lubrication* is one more important reason for starting to convert, today, to Life-Line power. Standard ratings available from stock—others on short delivery. Ask your Westinghouse representative for prices and delivery on your requirements, or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pa.

J-21527-A

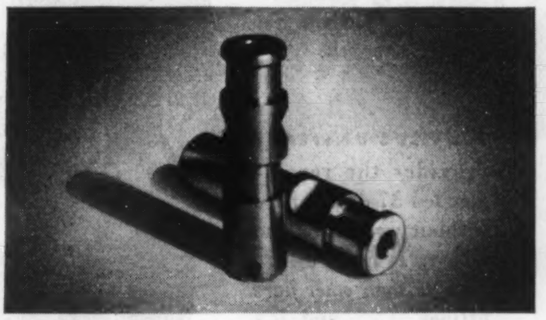
Westinghouse
Life-Line
Motors

Get Longer Life for your machines with HAYNES Alloy Parts

Trade-Mark

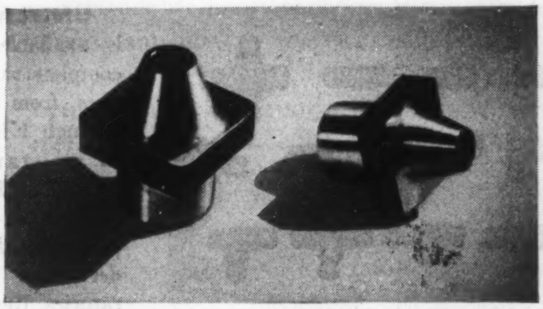
You can keep your machines running with fewer shutdowns for repairs or replacements by specifying HAYNES alloy parts to withstand severe abrasion, heat, or corrosion.

Many HAYNES alloy parts are standard items carried in stock. If you need special parts, they can be made on order to your specifications by casting, forging, or rolling—depending on the alloy and shape desired. The parts are completely finished, ready for use. They are ground to required tolerances, and polished—where needed—to mirror-like surfaces. Send us your drawings for quotations, or write for more detailed information.



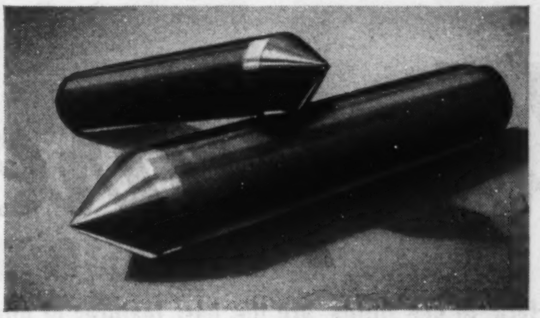
HAYNES STELLITE Alloy
Plunger Lever Pins

HAYNES STELLITE cobalt-base alloys are hard and strong, even at red heat—resist chemical and atmospheric corrosion—have a low coefficient of friction—and take and keep a high polish.



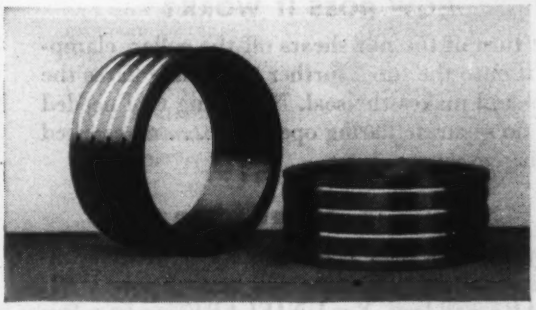
HASCROME Castings
Die-Casting Machine Nozzle

HASCROME castings contain chromium and manganese in an iron base—resist abrasion and severe impact—have an extremely high degree of toughness—and work-harden under impact.



HAYNES 93 Alloy
Lathe Centers

HAYNES 93 alloy is an iron-base composition that contains cobalt, chromium, molybdenum, and vanadium—has high cold hardness—and is highly resistant to abrasive wear from contact with other hard materials.



HASTELLOY Alloy
Piston Rings

HASTELLOY nickel-base alloys resist the most severe chemical corrosion—have excellent physical properties even at elevated temperatures—and are available in a grade that will take and keep a high polish.

HAYNES
TRADE-MARK
Alloys

Haynes Stellite Company
Unit of Union Carbide and Carbon Corporation
UCC
General Offices and Works, Kokomo, Indiana
Chicago—Cleveland—Detroit—Houston
Los Angeles—New York—San Francisco—Tulsa

The trade-marks "Haynes," "Haynes Stellite," "Hascrome," and "Hastelloy" distinguish products of Haynes Stellite Company.

Easier to Install

THAN A COMPRESSION FITTING

Stronger

THAN ANY OTHER FLARE FITTING

SCOVILL

Uniflare

Here, in one fitting, are the best features of other fittings with none of their disadvantages

SCOVILL'S UNIFLARE has only two parts—body and male-threaded nut. Goes on even *easier than a compression* fitting . . . and has far greater strength.

SCOVILL'S UNIFLARE provides the recommended 37 degree flare without weakening the tube. Has *greater strength than other flare* fittings . . . and it's self-flaring.

HOW DOES IT WORK?

One turn of the nut shears off the collar, clamping it onto the tube; further tightening flares the tube and makes the seal. No flaring tool needed . . . no separate flaring operation . . . no cracked tubing to worry about.

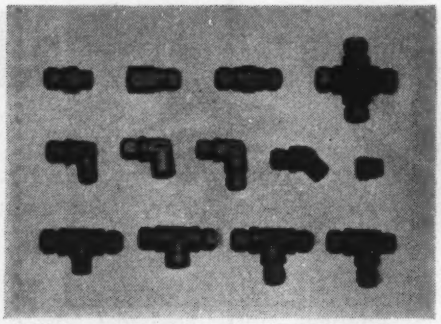
WHY IS IT STRONGER?

Special brass alloy permits more tightening, resists vibration. The tube will burst before UNIFLARE will leak. Yet UNIFLARE can be taken apart and reassembled many times.

ADVANTAGES TO DESIGNER

Specify lighter weight, less costly tubing . . . Save assembly time without sacrificing efficiency . . . Be sure UNIFLARE will hold up against vibration . . . Allow for repeated disassembly and reassembly.

Recommend for refrigeration, etc.—due to "anti-frosting" construction and Dryseal threads.



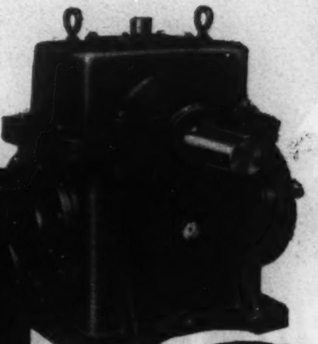
UNIFLARE is available in a complete range of sizes from ⅛ in. through 1 in. and in all standard shapes. Fully tested and approved by the Underwriters' Laboratories, Inc.

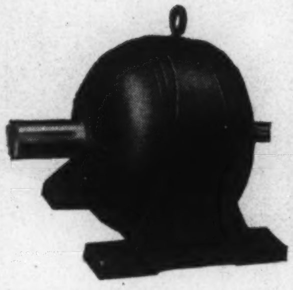
Investigate UNIFLARE for oil, air, water or hydraulic lines. Write on company letterhead for a working sample. Address Screw Machine Products Division, Scovill Manufacturing Company, 50 Mill Street, Waterbury 91, Conn.

A PRODUCT OF SCOVILL SCOVILL

Uniflare **The Complete, Self-flaring Tube Fitting**

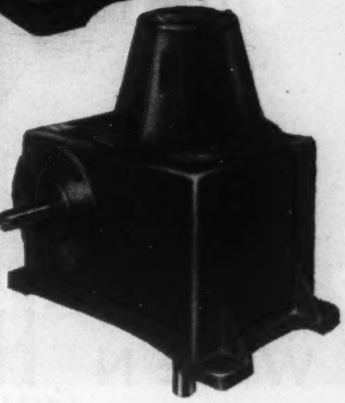
Foote Bros. Hypower Enclosed Worm Gear Drives assure economy in original cost and economy in operation. They bring a new compactness in design plus greatly increased thermal capacity. Available in vertical and horizontal types.





Foote Bros. Straight Line Enclosed Gear Drives will shortly be introduced. These compact units may be used with any standard motor. Ratios range from 5 to 240 to 1.

looking for drives?



THEN LOOK TO FOOTE BROS.

Foote Bros. Hytop Enclosed Worm Gear Drives provide wider low-speed bearing span. Ideal for installation where low-speed shaft extensions cannot be supported by pilot or guide bearings at the end of shaft. Available in both Hygrade and Hypower types.

If you require enclosed gear drives, the Foote Bros. line offers a wide variety of types, sizes and ratios to meet any need.

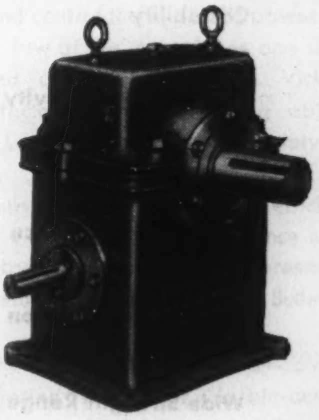
Nearly a century of engineering and manufacturing experience is back of Foote Bros. Drives. Two large plants contain the newest in gear generating equipment—new techniques in manufacture—better metallurgical control of materials—improved manufacturing methods—all assure you superior enclosed gear drives.

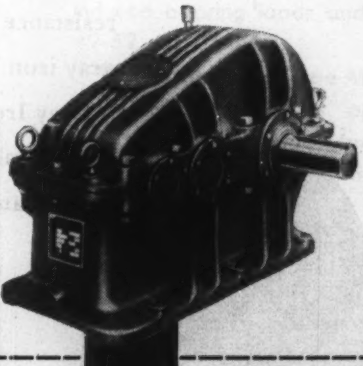
Mail the coupon for information.

AVAILABLE FROM STOCK

A new policy of distribution now makes Foote Bros. Enclosed Worm Gear Drives available from stock. A range of sizes and ratios is offered to meet many industrial applications.

Foote Bros. Hygrade Enclosed Worm Gear Drives have been newly engineered and now offer the maximum in rugged dependability. Specially designed for heavy-duty applications. Available in both horizontal and vertical types.





Foote Bros. Maxi-Power Helical Gear Drives are available in single, double and triple reductions. A newly engineered line that represents the last word in modern power transmission equipment.

FOOTE BROS.

Better Power Transmission Through Better Gears

FOOTE BROS. GEAR AND MACHINE CORPORATION
Dept. O, 4545 S. Western Blvd., Chicago 9, Illinois

Foote Bros. Gear and Machine Corporation
Dept. O., 4545 S. Western Blvd., Chicago 9, Ill.

Gentlemen: Please send me information on drives checked below:

☐ Hypower Enclosed Worm Gear Drives
☐ Hygrade Enclosed Worm Gear Drives
☐ Maxi-Power Enclosed Helical Gear Drives
☐ Straight Line Enclosed Gear Drives

Name..........
Company..........
Address..........
City.......... *State*..........

Diesel exhaust elbows used on U. S. Navy submarines illustrate heat resistance of Gray Iron.

WHEN HEAT MEETS GRAY IRON

Gray Iron Characteristics Include:

- **Castability**
- **Rigidity**
- **Low Notch Sensitivity**
- **Wear Resistance**
- **HEAT RESISTANCE**
- **Corrosion Resistance**
- **Machinability**
- **Vibration Absorption**
- **Durability**
- **Wide Strength Range**

Every housewife lucky enough to have inherited one of those indestructible iron skillets from her mother knows how it has withstood thousands of heatings without harm. Grate bars, fire baskets, radiators, stove and furnace parts are other popular gray iron products subject to constant heating and cooling.

In industry, many striking applications can be found. Take ingot molds, for example. Resistance to thermal shock, good heat conductivity, low coefficient of expansion and high wear resistance in the presence of heat are some of the reasons why gray iron is used so extensively throughout industry.

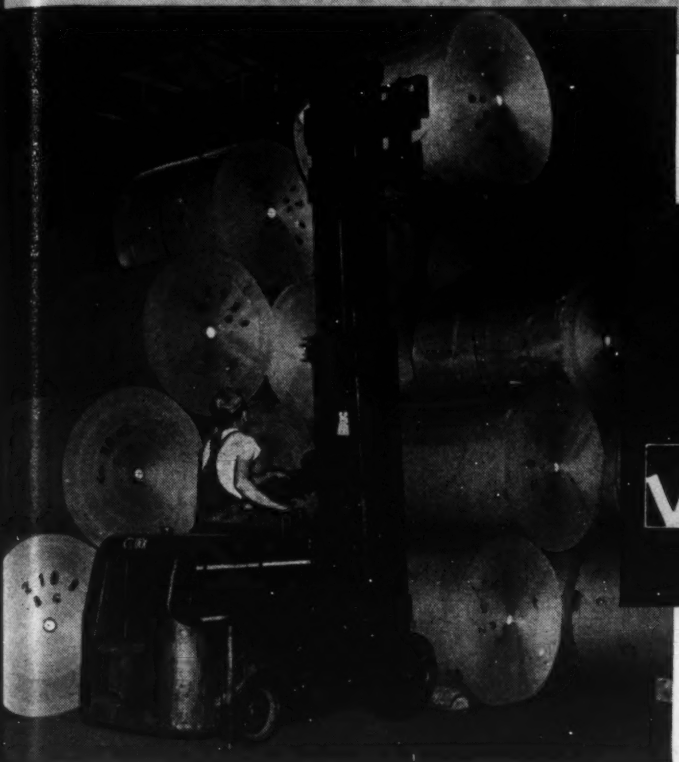
Gray Irons are available in a wide range of analyses and provide combinations of valuable properties unmatched by any other material . . . *plus ultimate economy.*

Write for free booklet—
"GRAY IRON—Its Mechanical and Engineering Characteristics, and Details for Designing Cast Components."

Make It Better With Gray Iron

GRAY IRON FOUNDERS' SOCIETY, INC.
NATIONAL CITY BANK BLDG., CLEVELAND 14, OHIO

CLARK ELECTRIC and GAS POWERED FORK TRUCKS



more Cost-Cutting

applications of

VICKERS HYDRAULICS

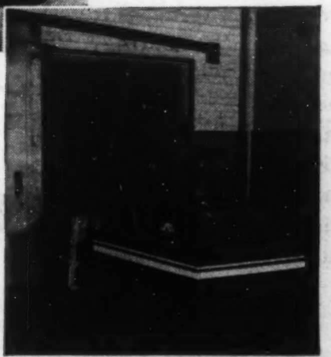
Clark Utilitruc (gas-powered) saves time in tiering heavy rolls of paper fiber board.

The Industrial Truck Division of the Clark Equipment Company uses Vickers Vane Type Pumps and Multiple-Unit Valves on all of its electric battery-powered models and on some of its gas-powered models to provide and control the hydraulic power for both lifting and tilting. Only a few of the many types and sizes of Clark Trucks so equipped are illustrated here. Vickers Hydraulics is an important factor in the cost-cutting ability demonstrated by Clark Fork Lift Trucks on a wide variety of materials handling operations.

Vickers Balanced Vane Pumps are notable for their efficient operation and long life. Their exclusive hydraulic balance construction prolongs pump life by entirely eliminating pressure-induced bearing loads and resulting wear. Write for Bulletins 49-52 and 36-12.

Vickers Sectional Type Multiple-Unit Valves are available in many combinations for operating single- or double-acting cylinders. They provide convenient and selective control and include relief valve for overload protection. Write for Bulletin 40-13.

Clark Elec-Utilitruc reduces the cost of handling locomotive parts in railroad shop yards.



Clark Elec-Carloader with Hi-Lo-Stack device passes easily through a 7 ft high door opening, yet it will tier to 130 inches with ease.

Vickers Multiple-Unit Valve
Vickers Balanced Vane Type Pump

VICKERS Incorporated
DIVISION OF THE SPERRY CORPORATION
1430 OAKMAN BLVD. • DETROIT 32, MICHIGAN

Application Engineering Offices:
ATLANTA • CHICAGO • CINCINNATI • CLEVELAND • DETROIT • LOS ANGELES
NEWARK • PHILADELPHIA • PITTSBURGH • ROCHESTER • ROCKFORD • ST. LOUIS
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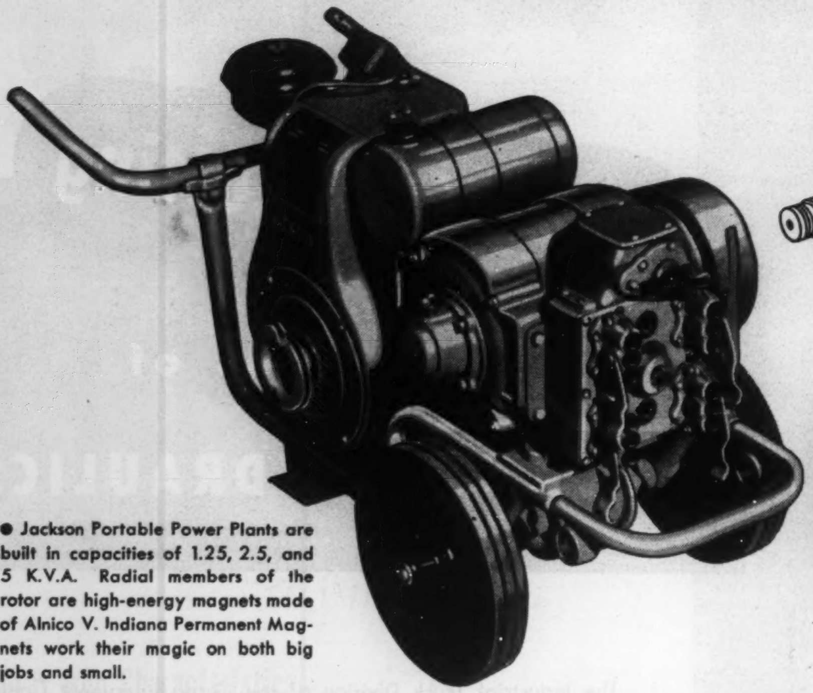
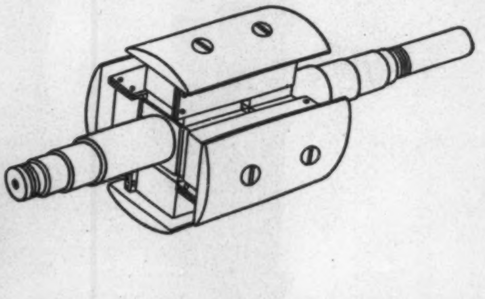
ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921

THIS PERMANENT-MAGNET ROTOR MEANS RELIABLE ROUND-THE-CLOCK POWER





● Jackson Portable Power Plants are built in capacities of 1.25, 2.5, and 5 K.V.A. Radial members of the rotor are high-energy magnets made of Alnico V. Indiana Permanent Magnets work their magic on both big jobs and small.

121 FEWER PARTS... LESS MAINTENANCE WITH INDIANA PERMANENT MAGNETS

121 fewer parts in a better, *more dependable* generator! That's what Indiana Permanent Magnets have done for Jackson Portable Power Plants. The rotor now is a permanent magnet field. There are no brushes or collector rings . . . no commutator sparking or arcing. Less heat is developed. Over-all size and costs are reduced. Maintenance is minimized. Here, again, modern design with Indiana Permanent Magnets is a *product plus* that pays.

INDIANA PERMANENT MAGNETS MAY BE YOUR ANSWER, TOO!

For four decades, the pace-setting design techniques at Indiana have made possible *new and better* permanent magnets. And, on countless different products, this versatile "packaged energy" improves performance, permits new functions, saves space *and money* . . . as mechanical force in holders and separating devices . . . in transforming electrical energy into mechanical motion, and vice versa . . . in changing the apparent characteristics of materials. Indiana offers you the *experience and know-how* of more than 30,000 different applications. Let's get our engineers together on *your* problems. Write today.

Free Book for Designers

Ask for free Book No. 4-H5—our new permanent magnet reference manual. A note on your company letterhead will bring a copy to your desk.

INDIANA PERMANENT MAGNETS

THE INDIANA STEEL PRODUCTS COMPANY

6 NORTH MICHIGAN AVENUE • CHICAGO 2, ILLINOIS

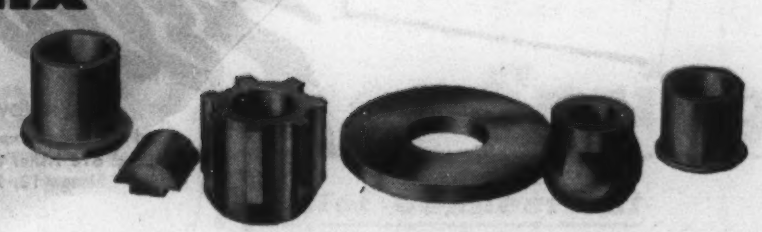
SPECIALISTS IN "PACKAGED ENERGY" SINCE 1908

gramix gears

help this mechanical counter run for years without a miss!

The Silver King Mechanical Counter manufactured by The Production Instrument Co., of Chicago, meets the exacting requirements of industry for accuracy and dependability. It keeps right on counting, year after year, without a miss. Two good reasons why this practical counter *operates without maintenance* are the two Gramix Gears that form the heart of the machine. They are roughly equivalent to the transmission on a car. Not only do they do their appointed job unfailingly, but *their original cost is but a fraction* of that of the machined parts formerly used in the instrument. Gramix parts are precision-pressed from powdered metals and require no costly machining and hand finishing. The lubrication is impregnated right into the processed metal and never needs additional oil. Gramix powdered metal bearings, bushings, gears and machine parts *can be made in any practical size and shape.* Perhaps we can show how Gramix can help you maintain the dependability of your product and at the same time greatly reduce your cost of manufacture. Send us your prints for specific recommendations and ask for the 264 page Gramix catalog.

gramix



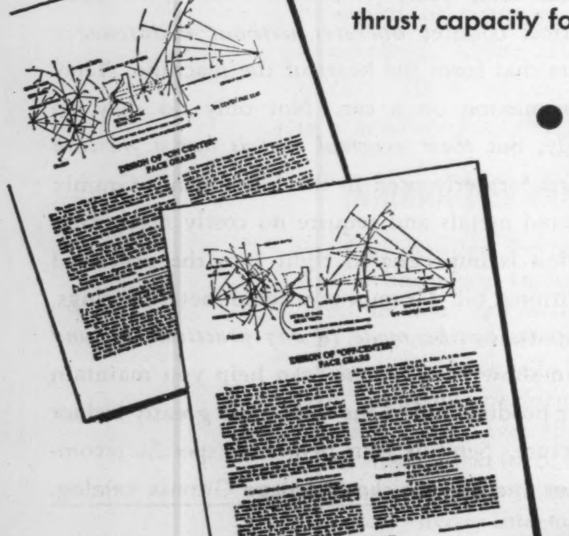
THE UNITED STATES GRAPHITE COMPANY • SAGINAW, MICHIGAN

FACE GEARS

Design Solution to ANGULAR DRIVES

The face gear offers inviting possibilities to the designer for 90° and other angular drives. Both face gear and pinion can be produced with high accuracy on the Gear Shaper—and at costs so low as to invite designers to prefer this type of gear for many angular drives.

Outstanding advantages are: more compact design, no appreciable thrust, capacity for high speed, and low cost of production.


DESIGN OF "ON-CENTER" FACE GEARS
DESIGN OF "OFF-CENTER" FACE GEARS

● Instructions for Designing Face Gears

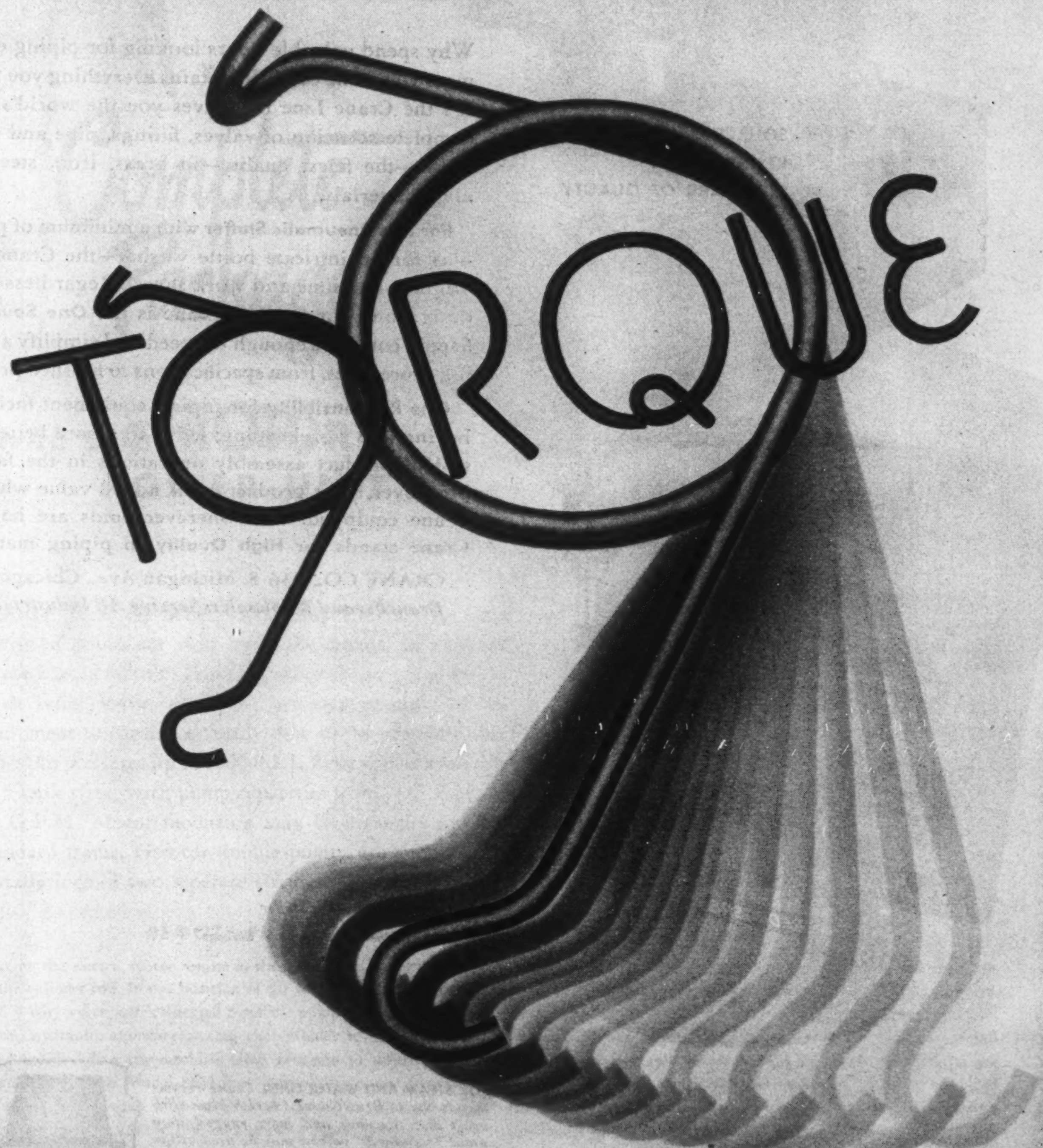
These new data sheets explain a simplified procedure for determining the active face width for "on-center" and "off-center" face gears. Copies can be obtained by writing our nearest office. A special bulletin of principles and applications of face gears is also available.

Fellows

THE FELLOWS GEAR SHAPER COMPANY

Head Office and Export Dept., Springfield, Vermont. Branch Offices: 616 Fisher Bldg., Detroit 2; 640 West Town Office Bldg., Chicago 12; 7706 Empire State Bldg., New York 1.

GEAR SHAPERS • THREAD GENERATORS • CUTTERS • SHAVING AND BURNISHING MACHINES
GEAR MEASURING AND INSPECTION INSTRUMENTS • PLASTICS MOLDING MACHINES



Wallace Barnes Springs

Bristol Connecticut

Time-saver for machine designers
. . . the complete CRANE line

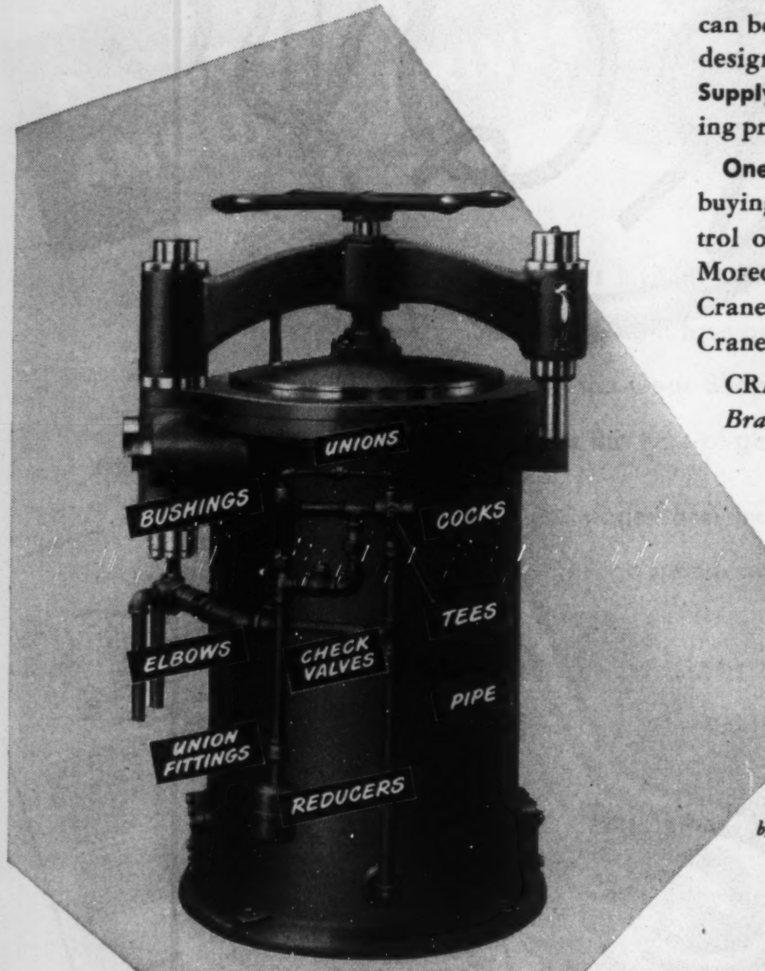
ONE SOURCE OF SUPPLY
RESPONSIBILITY
STANDARD OF QUALITY

Why spend valuable hours looking for piping equipment when one catalog contains everything you need? It's the Crane Line that gives you the world's most complete selection of valves, fittings, pipe and accessories—the finest quality—in brass, iron, steel and alloy materials.

For This Pneumatic Stuffer with a minimum of piping—as for an intricate bottle washer—the Crane Line can be a real time and work saver. Regardless of the design on your boards, Crane is the **One Source of Supply** complete enough to speed and simplify all piping procedures, from specifications to finished product.

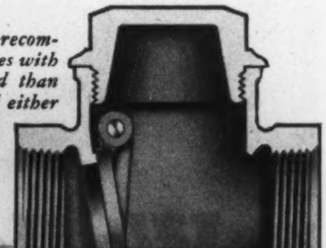
One Responsibility for piping equipment facilitates buying and storekeeping; helps to assure better control of product assembly operations in the factory. Moreover, your product gains added value when it's Crane equipped. For wherever fluids are handled, Crane stands for **High Quality** in piping materials.

CRANE CO., 836 S. Michigan Ave., Chicago 5, Ill.
Branches and Wholesalers Serving All Industrial Areas



Pneumatic Stuffer for meat products by the Globe Company, Chicago

FOR STEAM AND WATER LINES, *Crane recommends No. 34 Brass Swing Check Valves with brass disc. Heavier and more rugged than usual "standard" valves; may be used either in horizontal position, or in vertical position for upward flow. Working pressures: 125 pounds steam, 200 pounds cold water, non-shock. Sizes: 3/8 to 3 in. See your Crane Catalog, p. 55.*



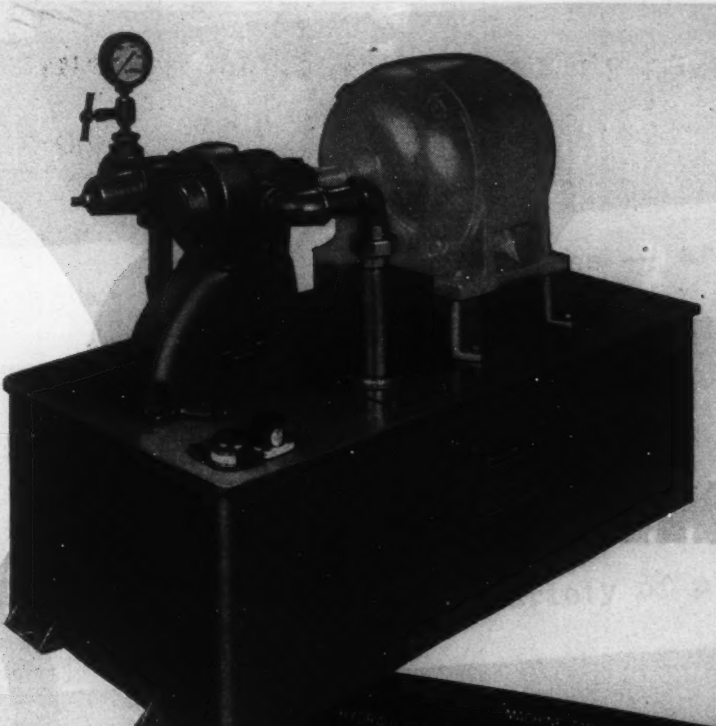
EVERYTHING FROM . . .

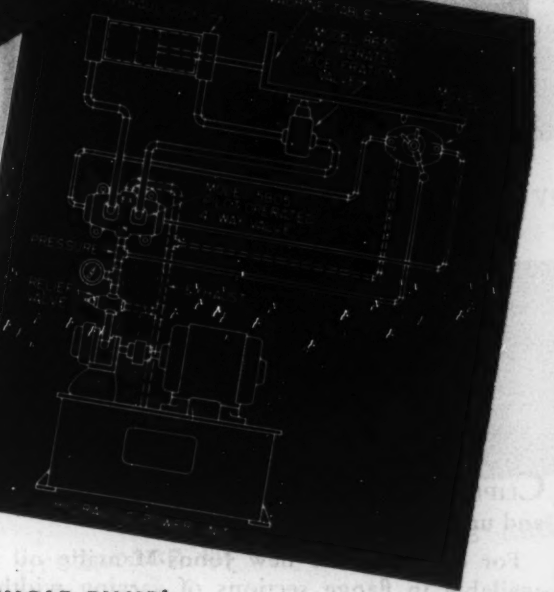
VALVES • FITTINGS
PIPE • PLUMBING
AND HEATING

CRANE

FOR EVERY PIPING SYSTEM

YOU GET A *Complete Package* -with a GEROTOR POWER UNIT

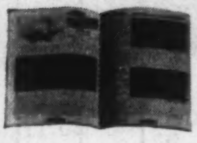




Gerotor offers the Series 9100 Pump Unit as the ideal source of power for your hydraulic circuit. In addition to the highly efficient Gerotor pump, the unit is equipped with relief valve, oil filter, pressure gauge, and all equipment to furnish a steady flow of oil at continuous working pressures up to 1000 P.S.I. Reservoir is available in 5 tank sizes, with pump capacities from .4 G.P.M. to 40 G.P.M. Motor mounting may be arranged for any standard frame. Gerotor double pumps are supplied for installations of two separate circuits.

● REMOTE PILOT OPERATED CONTROL (SINGLE PUMP)

Starting the electric motor results in the continuous reciprocating of the cylinder rod. In one position of the Model 5805 Pilot operated 4-Way valve, oil is directed from the pump to the blind end of the hydraulic cylinder, causing the cylinder to extend at its rated speed. When the machine table advances to where it depresses the cam of Model 8630 flow control valve, the forward speed of the cylinder is affected by the setting of the flow adjusting screw of Model 8630 valve. In the other position of Model 5805 valve, oil is directed from the pump to the rod end of the hydraulic cylinder causing it to retract at full rated speed. In this direction of cylinder movement, Model 8630 has no effect on the speed of the cylinder. Model 7205 Pilot valve provides for remote hydraulic operation of the main 4-Way valve, Model 5805. The forward, or return stroke of the cylinder may be manually interrupted at any time by reversing the handle of the Model 7205 Pilot valve.

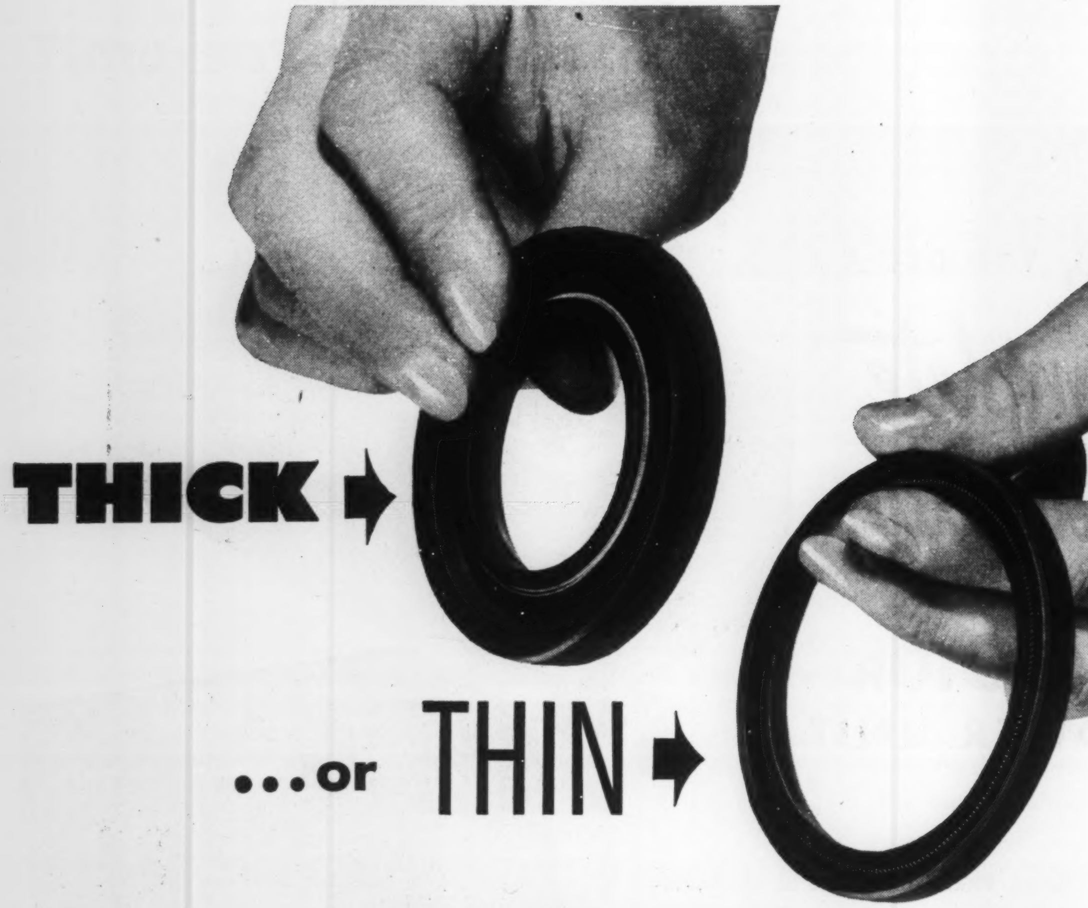


Write for Catalog Section G-105 showing specifications and description of Gerotor Hydraulic Pump Units.

GEROTOR MAY CORPORATION • Dept. MD-5 Baltimore 3, Md.

WHEN YOU APPLY HYDRAULIC OR AIR POWER *Plan with* GEROTOR

AIR AND HYDRAULIC VALVES AND CYLINDERS, HYDRAULIC PUMPS, MOTORS AND PUMP UNITS



...an oil seal design for *any* cavity

CLIPPER SEALS offer unusual design possibilities . . . and unusual design economies, too.

For example, this new Johns-Manville oil seal is available in flange sections of varying width to fit practically any cavity. In fact, because of the adaptability of its unique one-piece design, there is no cavity mechanically practicable which is too shallow—or too deep—for a Clipper Seal.

Furthermore, because the Clipper Seal has no metal case and is of flexible molded construction, this oil seal permits liberal machining tolerances in the design of the cavity. Its tough, dense outer heel is resilient enough to conform to even a slightly out-of-round cavity. Yet this does not interfere with the seating of the pliable inner lip which always maintains a light, but positive sealing pressure on the shaft for minimum wear.

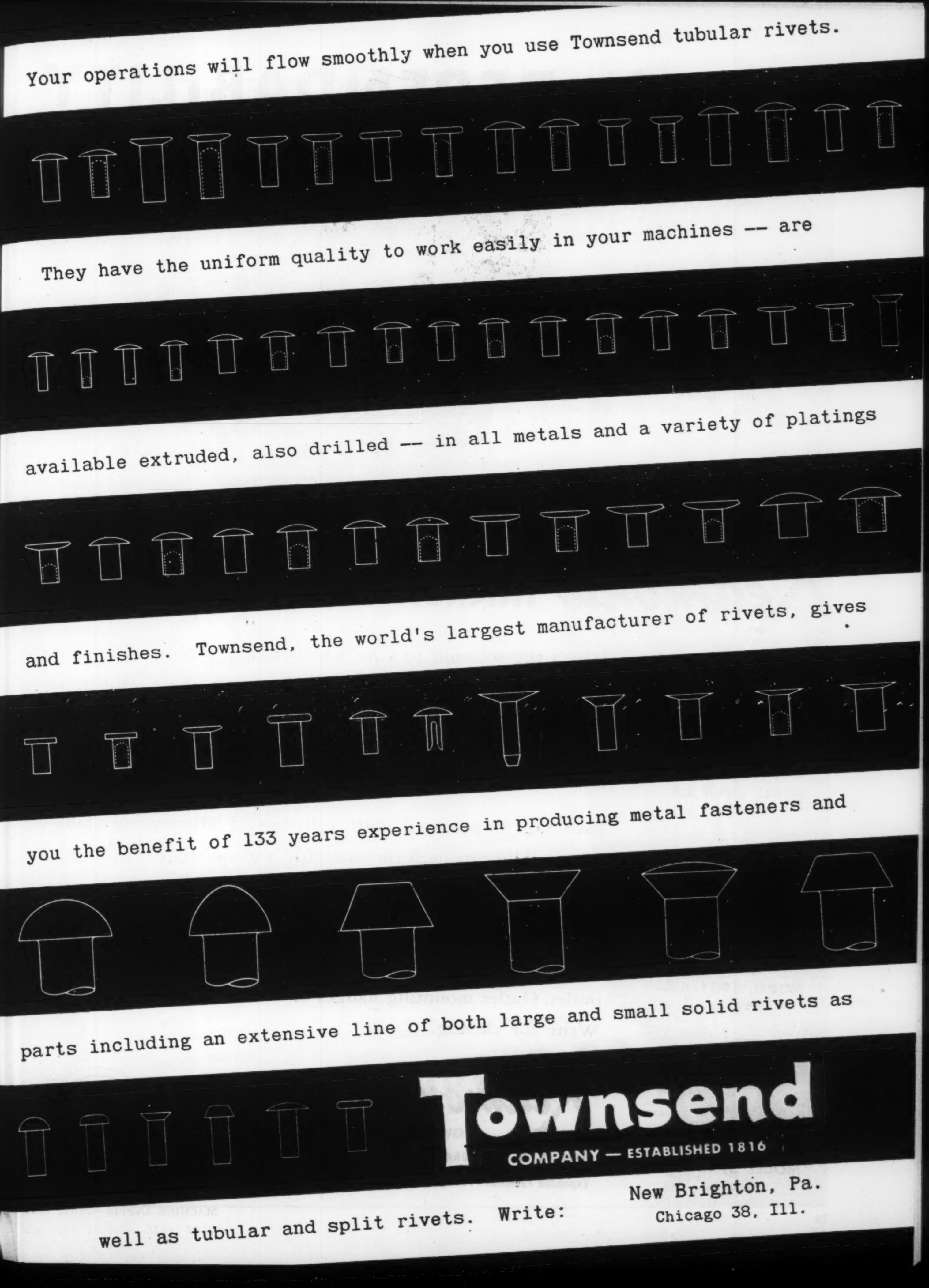
Clipper Seals are entirely non-metallic, which eliminates the possibility of electrolysis; are available in split and endless types, for sealing against oil, grease, water, air, grit and coolants, in sizes from 1/4" I. D. to 66" O. D. If you would like to consult us about a design problem, write Johns-Manville, Box 290, New York 16, N. Y.

Recommended Clipper Seal Flange Sections

		Light		Medium		Heavy	
Shaft Diameter Inches	Increments	Flange Width	Heel Depth	Flange Width	Heel Depth	Flange Width	Heel Depth
5/8 thru 1 1/2	1/16"	1/4"	5/16"	5/16"	5/16"	3/8"	7/16"
1 9/16 " 2	1/16"	5/16"	5/16"	3/8"	7/16"	1/2"	7/16"
2 1/8 " 2 7/8	1/8"	5/16"	5/16"	3/8"	7/16"	1/2"	7/16"
3 " 5 7/8	1/8"	3/8"	7/16"	1/2"	7/16"	5/8"	5/8"
6 " 9 7/8	1/8"	1/2"	7/16"	5/8"	5/8"	3/4"	5/8"
10 " 19 3/4	1/4"	5/8"	5/8"	3/4"	5/8"	1"	7/8"
20 " 29 3/4	1/4"	3/4"	5/8"	1"	7/8"	1 1/4"	7/8"
30 " 36	1/4"	1"	7/8"	1 1/4"	7/8"		

Recommended dimensions for shaft diameters from 1/4" to 5/8" and over 36" on request.

Johns-Manville **PACKINGS & GASKETS**

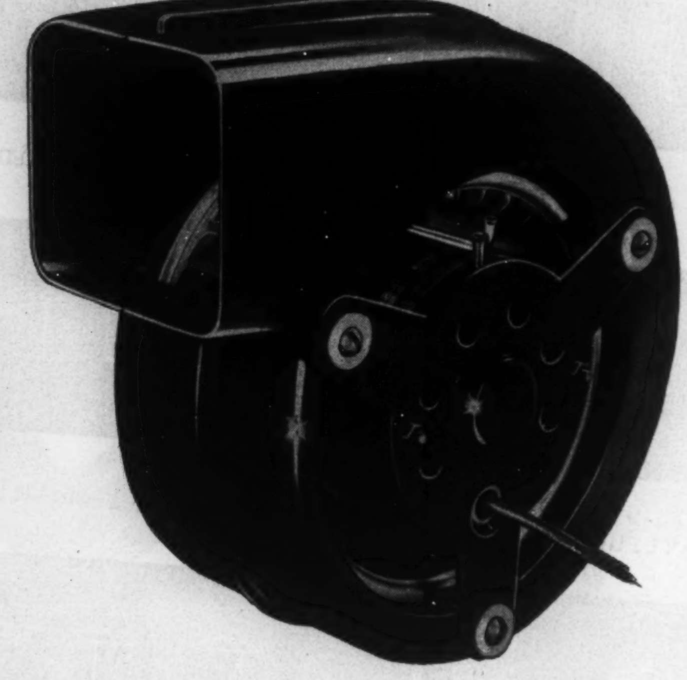


Your operations will flow smoothly when you use Townsend tubular rivets. They have the uniform quality to work easily in your machines -- are available extruded, also drilled -- in all metals and a variety of platings and finishes. Townsend, the world's largest manufacturer of rivets, gives you the benefit of 133 years experience in producing metal fasteners and parts including an extensive line of both large and small solid rivets as well as tubular and split rivets. Write:

Townsend
COMPANY — ESTABLISHED 1816

New Brighton, Pa.
Chicago 38, Ill.

built-in DEPENDABILITY



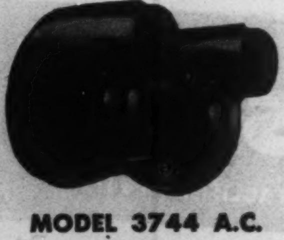
MODEL 3802

This compact motor-in-wheel A.C. blower unit delivers 100 Cubic feet per minute

Redmond MICROMOTOR BLOWER UNITS

MODEL 3866 A.C.
150 C.F.M.

MODEL 3901 A.C.
220 C.F.M.



MODEL 3744 A.C.
100 C.F.M.

Here's the solution to your small-blower problems . . . choose a Redmond Micromotor Blower Unit. Compact, sturdy, and thoroughly dependable, these units are built to give long-lasting satisfaction. Precision balancing of all moving parts minimizes vibration, assures quiet operation.

Each unit is powered with a Redmond Micromotor, famous for its ability to perform smoothly and quietly over thousands of hours of continuous duty.

A. C. blowers available in capacities from 50 C. F. M. to 220 C. F. M.; D. C. blowers up to 125 C. F. M. Single or double outlet. Outlet mounting flanges and inlet screens also available. Write for catalog.

Redmond COMPANY, INC.
OWOSSO, MICHIGAN
OFFICES IN NEW YORK, CHICAGO, DAYTON, LOS ANGELES, DALLAS
Expanded Facilities • Prompt Deliveries • Service before and beyond the sale

REDMOND ®

Wichita City Library

The Magic of SILICONE RUBBER

Specify Silicone Rubber on the Drawing Board to Solve High and Low Temperature Problems

Thousands of Silicone rubber parts are shipped daily to manufacturers who need a rubber capable of withstanding temperatures from a low of -160 to a high of more than 500° F. These parts, in many cases, have been designed to replace metal constructions in which limited thermal stability has been experienced.

Silicone rubber has most of the desirable characteristics of natural rubber in addition to special properties, and is suitable for dielectric applications. Also, this new rubber is resistant to permanent compression, prolonged weathering, lubricating oils and many chemicals.

Gaskets, diaphragms, grommets, seals, packings, tubing and other Silicone rubber fabrications are recommended for use in steam generators, gas cylinders, jet and conventional aircraft engines, electrical heating apparatus, electric motors, transformers, die casting machines, refrigeration and air conditioning equipment, and industrial ovens.

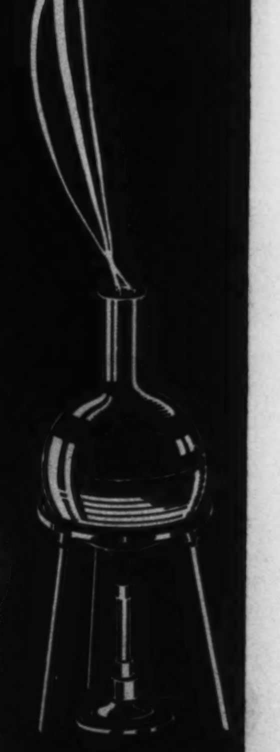
The Stalwart Rubber Company will fabricate Silicone rubber to your individual specifications. Modern engineering facilities and unerring production methods assure precision rubber products.

STALWART RUBBER
BEDFORD OHIO

Complete laboratory facilities are available for the compounding of all types of special rubbers to meet either very limited or very broad applications, for developing new compounds to solve specific engineering problems, and for testing all types of rubbers to determine their suitability for various applications.

WRITE FOR CATALOG TODAY

Specify Stalwart — for Quality Custom Rubber Products



STALWART RUBBER CO.

5180 NORTHFIELD ROAD
BEDFORD, OHIO

INSUROK

By

RICHARDSON

DEPENDABLE NAMES IN PLASTICS

A RECORD OF SERVICE—The Richardson Company is proud of the contribution Laminated and Molded INSUROK have made to industrial progress.

INSUROK has become a symbol of quality wherever plastics are used, and Richardson laboratory, engineering and production skills have written important chapters in the development of many products, both for military and peace-time use.

We mention past accomplishments only because they may help you understand that Richardson can offer experienced help in every phase of the planning and production of plastics parts.

Why not send us specifications today . . . and learn how Richardson experience and facilities can work for you?

The RICHARDSON COMPANY

GENERAL OFFICES: LOCKLAND, OHIO FOUNDED IN 1858

Sales Headquarters: MELROSE PARK, ILLINOIS

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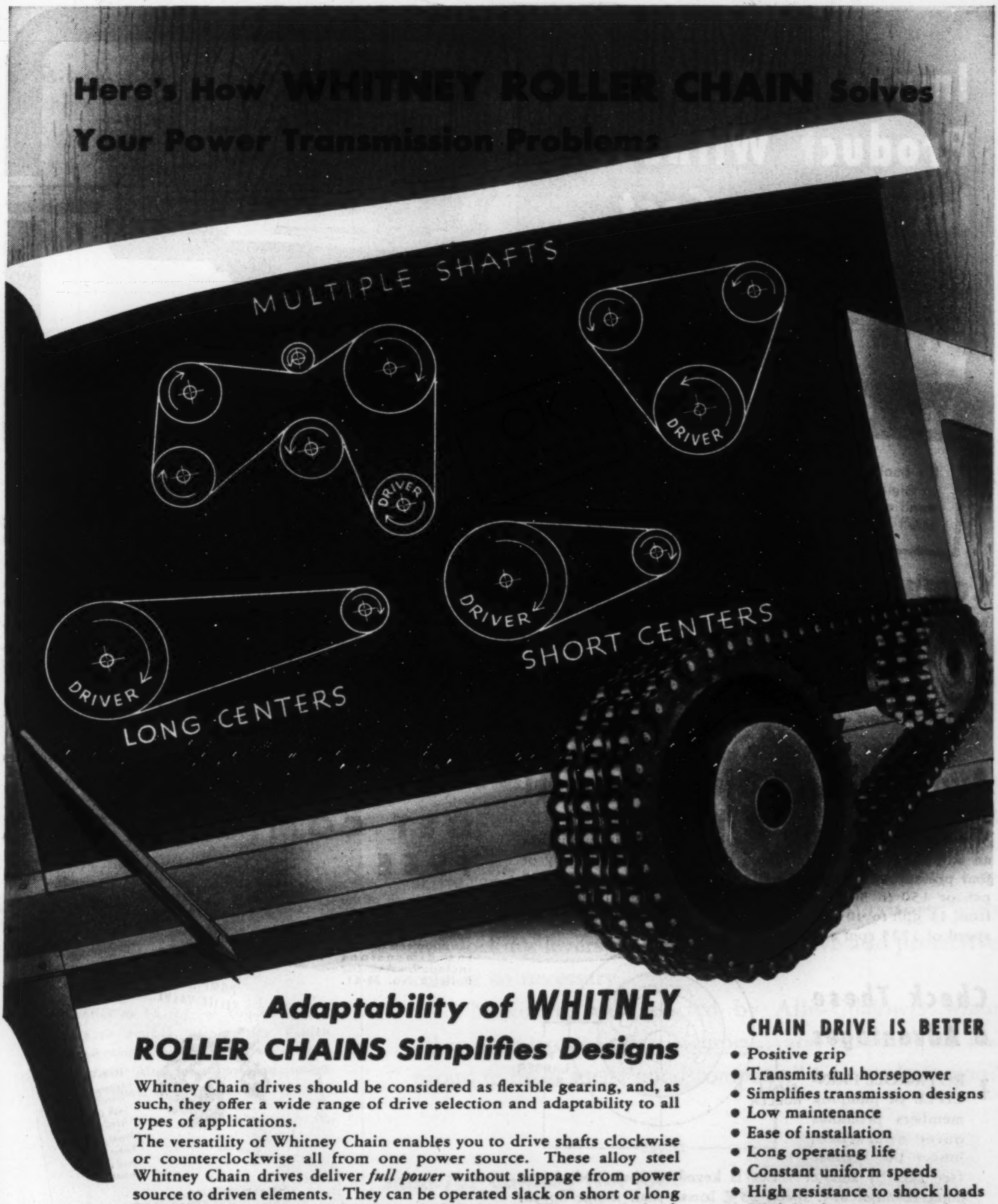

Here's How WHITNEY ROLLER CHAIN Solves
Your Power Transmission Problems
MULTIPLE SHAFTS
DRIVER
DRIVER
DRIVER
SHORT CENTERS
DRIVER
LONG CENTERS

Adaptability of WHITNEY ROLLER CHAINS Simplifies Designs

Whitney Chain drives should be considered as flexible gearing, and, as such, they offer a wide range of drive selection and adaptability to all types of applications.

The versatility of Whitney Chain enables you to drive shafts clockwise or counterclockwise all from one power source. These alloy steel Whitney Chain drives deliver *full power* without slippage from power source to driven elements. They can be operated slack on short or long centers. They do not impose excess loads on shaft bearings. They absorb shock and overloads without breakage. They can be put on or taken off without disconnecting shafts or gears.

No matter what your power drive problems Whitney Chains and Cut Tooth Sprockets . . . *the all-steel drives* . . . will meet your requirements. Write for complete details, today.

CHAIN DRIVE IS BETTER

- Positive grip
- Transmits full horsepower
- Simplifies transmission designs
- Low maintenance
- Ease of installation
- Long operating life
- Constant uniform speeds
- High resistance to shock loads
- High load carrying capacity

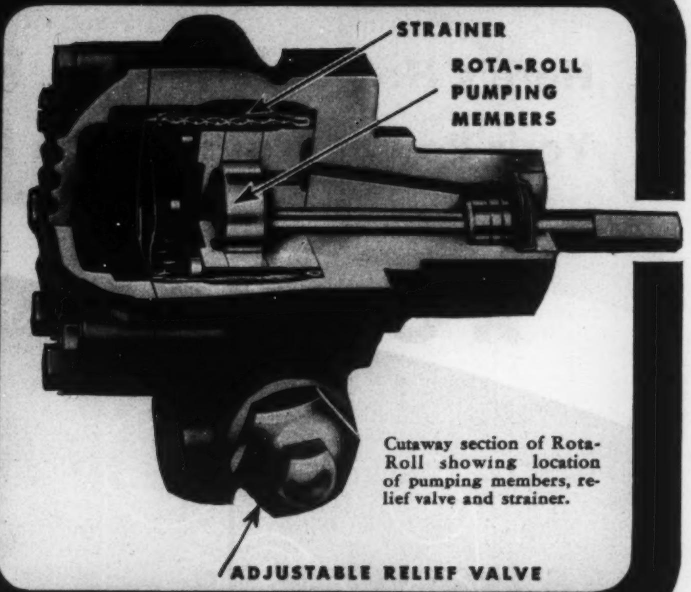
WHITNEY CHAIN & MFG. CO.
DIVISION OF WHITNEY-HANSON INDUSTRIES, INC.
205 Hamilton Street, Hartford 2, Conn.

WHITNEY
[illegible]
ROLLER CHAIN DRIVES

Improve Your Product Without Increasing Cost...

With This Low Pressure, Low Cost Pumping Unit

It's small, compact and ideal for applications such as engine lubrication, compressor bearing lubrication, small capacity oil transfer, barber and dental chairs, small cylinder actuation and many others.



Cutaway section of Rota-Roll showing location of pumping members, relief valve and strainer.

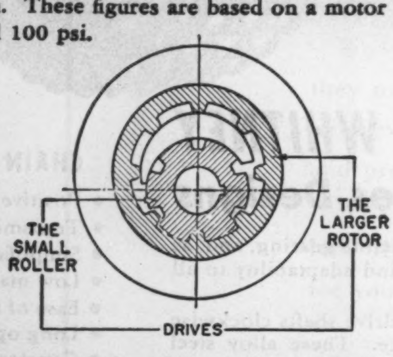
Complete With Pump, Relief Valve and Strainer

The Sundstrand Rota-Roll is more than a pump. It's a *pumping unit* complete with pump, relief valve and strainer. It's produced in large quantities on high production machinery — making its cost less than the cost of most pumps alone.

Available in 6 Sizes: From 11 G.P.H. to 40 G.P.H.

This pump has an adjustable relief valve which can be furnished in any of four pressure ranges of 20 to 40 psi, 40 to 80 psi, 80 to 150 psi, or 150 to 300 psi. The six capacities available range from 11 gph to 40 gph. These figures are based on a motor speed of 1725 rpm and 100 psi.

Check These 6 Advantages



1 ROTA-ROLL PRINCIPLE of pumping members promotes quiet operation, longer life because (see sketch) smaller roller is keyed to shaft and drives outer member at a speed 25% lower than motor speed.

2 QUIET OPERATION because ROTA-ROLL pumping members and efficient inlet port design reduces cavitation at the inlet port.

3 SMOOTH UNIFORM FLOW AT ALL PRESSURES because rotating roller and rotor are self-emptying, eliminating turbulence, and other interference with smooth, uniform flow of oil.

4 SMALL AND COMPACT (see illustration) will lend itself to and improve your product appearance.

5 HIGH OVERALL EFFICIENCY at maximum continuous duty pressure.

6 LOW COST OF THE ROTA-ROLL pumping unit is achieved through mass production manufacturing.

GET COMPLETE DATA FREE

Look into all of the features of this outstanding pumping unit. Complete description and mounting dimensions included. Ask for bulletin No. M-41.

The Sundstrand
Rota-Roll
Including
PUMP... RELIEF VALVE...STRAINER

For-
- Engine Lubrication
- Compressor Bearing Lubrication
- Small Capacity Oil Transfer
- Dental Chairs
- Barber Chairs
- Small Cylinder Actuation

In a Low Pressure - Low Cost Compact Pumping Unit

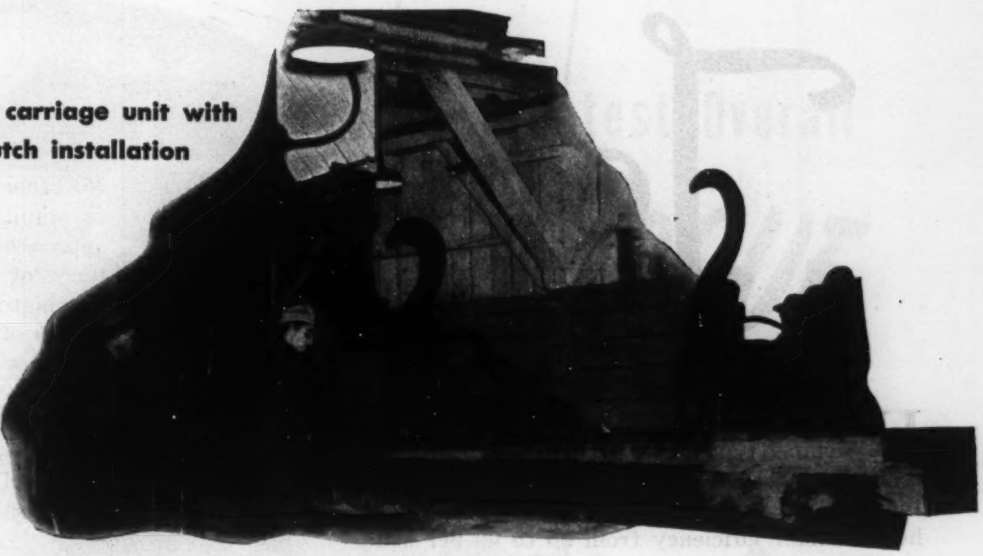
SUNDSTRAND MACHINE TOOL CO. · ROCKFORD, ILLINOIS, U.S.A.

SUNDSTRAND HYDRAULIC DIVISION

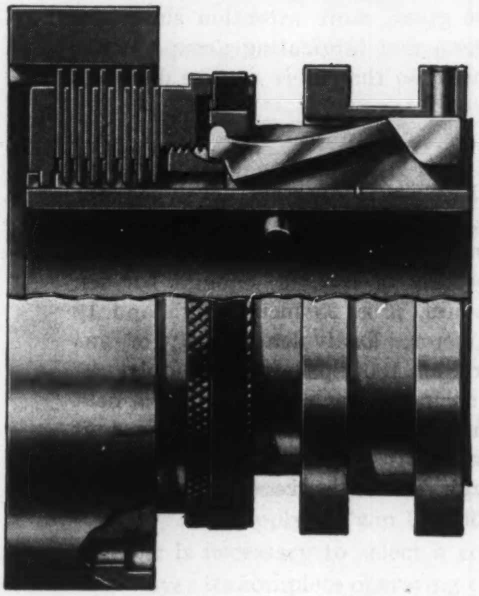
2559 ELEVENTH STREET • ROCKFORD, ILLINOIS

FUEL UNITS • HYDRAULIC PUMPS • TRANSMISSIONS • FLUID MOTORS • VALVES and CONTROLS

ALLIS-CHALMERS saw mill carriage unit with Maxitorq Floating Disc Clutch installation



MAXITORQ



... keeps Good Company

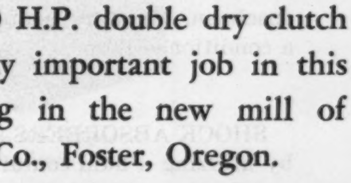
The Maxitorq No. 27 10 H.P. double dry clutch (2¾" bore) performs a vitally important job in this Allis-Chalmers band head rig in the new mill of Willamette National Lumber Co., Foster, Oregon.

Working large logs (to 35,000 lbs.) requires overcoming of considerable static friction in starting the log advance to set position. Then, the skilled operator must sense and feel decreasing changes in force in a few seconds as he holds the clutch lever. The Maxitorq, with non-locking levers, provides the sensitive and protective release so necessary.

Maxitorq was selected by Allis-Chalmers when other units proved unsatisfactory...and naturally we are proud to be in such "good company." Can we help you?

Capacities to 15 H.P. at 100 R.P.M.... single or double, wet or dry. Clutch shipped completely assembled ready to slip onto shaft. Also in pulley and cut-off coupling types.

Send for Catalog No. MD5



3CJ49

THE CARLYLE JOHNSON MACHINE COMPANY

MANCHESTER • CONNECTICUT

Topics

HEATING ELEMENT of the electrical resistance type may be sprayed onto surfaces to be heated, the element being separated from the part by a thin insulating coating. Having a heat-transfer efficiency from 90 to 95 per cent, the material was developed by Electrofilm Corp. for deicing critical surfaces of high-speed aircraft.

NONDESTRUCTIVE MEASUREMENT of abrasive wear of textiles depends only on the change in capacitance of the specimen with wear. In a method, developed for the Army by the National Bureau of Standards, amount of wear is a function of the capacitance between fixed electrodes of air, unworn specimen and abraded specimen. Moisture content is kept constant in a conditioned room.

SHOCK ABSORBERS may be made adjustable by utilizing a fluid containing magnetic particles and having viscosity controllable by means of a magnetic field, according to Jacob Rabinow inventor of the magnetic-particle fluid clutch.

PLASTIC FOAM insulating material, made from synthetic phenolic resin may now be foamed into place as needed, saving considerable storage and shipping space inasmuch as the foam has 100 times more volume than the molasses-like resin from which it is made. Developed by Westinghouse and weighing less than some gases, the new material is resistant to fire, moisture, fungus growth, and insects.

INVENTORS EXPOSITION, sponsored by American Inventors Assn. and to be held in New York on June 4 to 11, will provide an opportunity for individual inventors, particularly, to sample public opinion and at the same time show their products to industry.

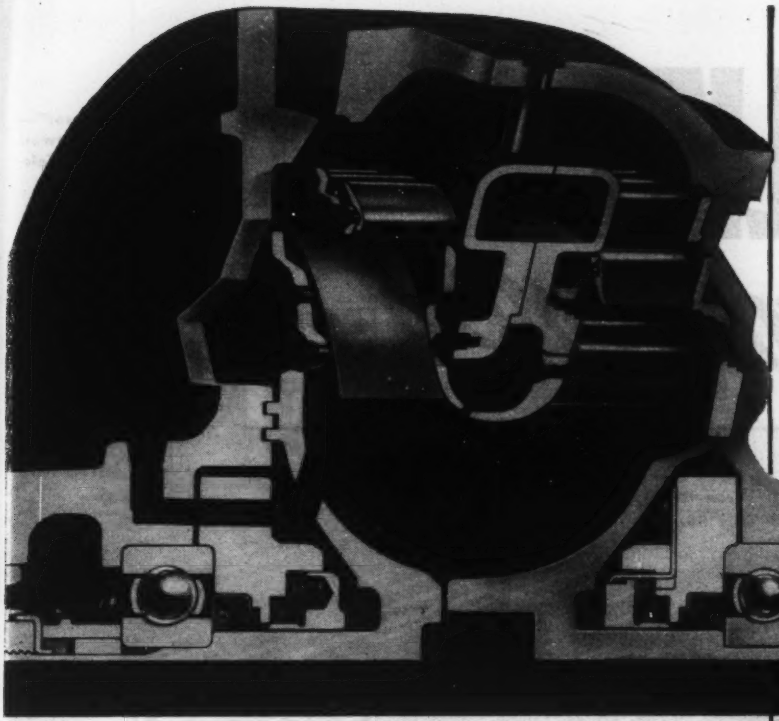
TITANIUM METAL is practically unaffected by exposure to sea water or marine atmospheres. No other structural metal, such as stainless steel or aluminum, approaches the corrosion resistance of titanium, according to Remington Arms Co. Inc., producers of the metal. It also has very low corrosion rates in wet chlorine gas, hot chromic acid and hot ferric chloride solutions. Obtained from ores which are abundant in North America, titanium is intermediate in weight between aluminum and steel and has a high strength-weight ratio.

ALLOY DEVELOPMENTS probably cannot be maintained at the same rate as in the past, according to M. H. Young, Wright Aeronautical Corp. Because the importance of minimizing thermal gradients for jet engine blades and rotor disks is so great, more attention should be paid to designing and fabricating around materials now at hand so that more service data can be accumulated.

LIQUID OXYGEN converter, developed for use in high-altitude flying, is fully automatic and requires no outside source of heat or power. Holding 62 pounds of oxygen, enough for ten men for 10 hours, it is 25 inches high and 18 inches in diameter. Equivalent supply of gas from cylinders at 1800 psi would require 21 tanks of 514 cu inches each. Limitation is heat absorption during storage which is 5 per cent per day. Excess pressure when not in use is bled off through a relief valve. Weight of converter is 60 pounds.

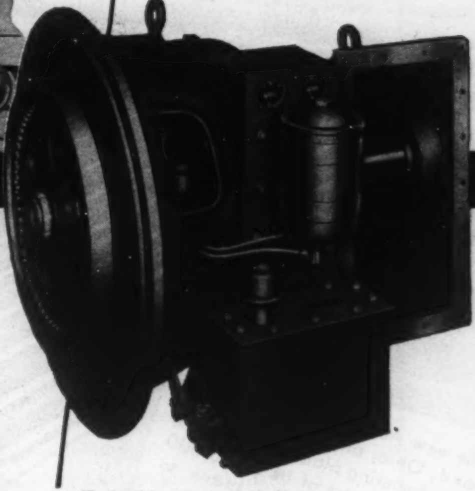
FAST-CURING phenolic powders, developed by General Electric for high-speed automatic molding, have effected production increases up to 25 per cent as a result of shorter curing times.

NODULAR GRAY IRON, developed recently by British and American researchers, extends the range of mechanical properties beyond those of gray iron. Having tensile properties as high as 100,000 psi and elongations as high as 20 per cent, nodular gray iron eventually may cross over into the field of low-alloy cast steel. Limitations, however, include low values of vibration resistance, self-lubricating friction properties and castability. Commercial production probably will be a year or more in the future.



Sectioned view of Twin Disc Hydraulic Torque Converter

Greatest • Overall *TORQUE* Multiplication



Twin Disc Hydraulic Torque Converter (Lysholm-Smith Type)

When considering power transmission units for equipment with high torque demands, designers turn naturally to Twin Disc's Lysholm-Smith Hydraulic Torque Converter, because it offers the greatest overall torque multiplication of any unit made today.

The hydraulic circuit of Twin Disc's Converter consists of a centrifugal pump discharging through a *three-stage* turbine, with two reaction stages interposed between the turbine stages. Maximum torque is developed at output shaft stall and is approximately five times engine torque . . . maximum efficiency is attained at an output speed ratio of approximately .5.

To apply a Twin Disc Torque Converter to any engine and machine assembly, it is necessary to select a converter with a proper pump size to absorb engine hp over its complete operating range. The drive ratios in the machine must be properly selected to obtain maximum converter performance throughout the complete range of output shaft operating speed.

The Twin Disc Hydraulic Division offers assistance in solving your power transmission problems. Torque Converter models are currently available with horsepower ratings from 50 to 600 hp. **TWIN DISC CLUTCH COMPANY**, Racine, Wisconsin (Hydraulic Division, Rockford, Illinois).

Power Take-off

Heavy Duty Clutch

Machine Tool Clutch

TWIN DISC

CLUTCHES AND HYDRAULIC DRIVES

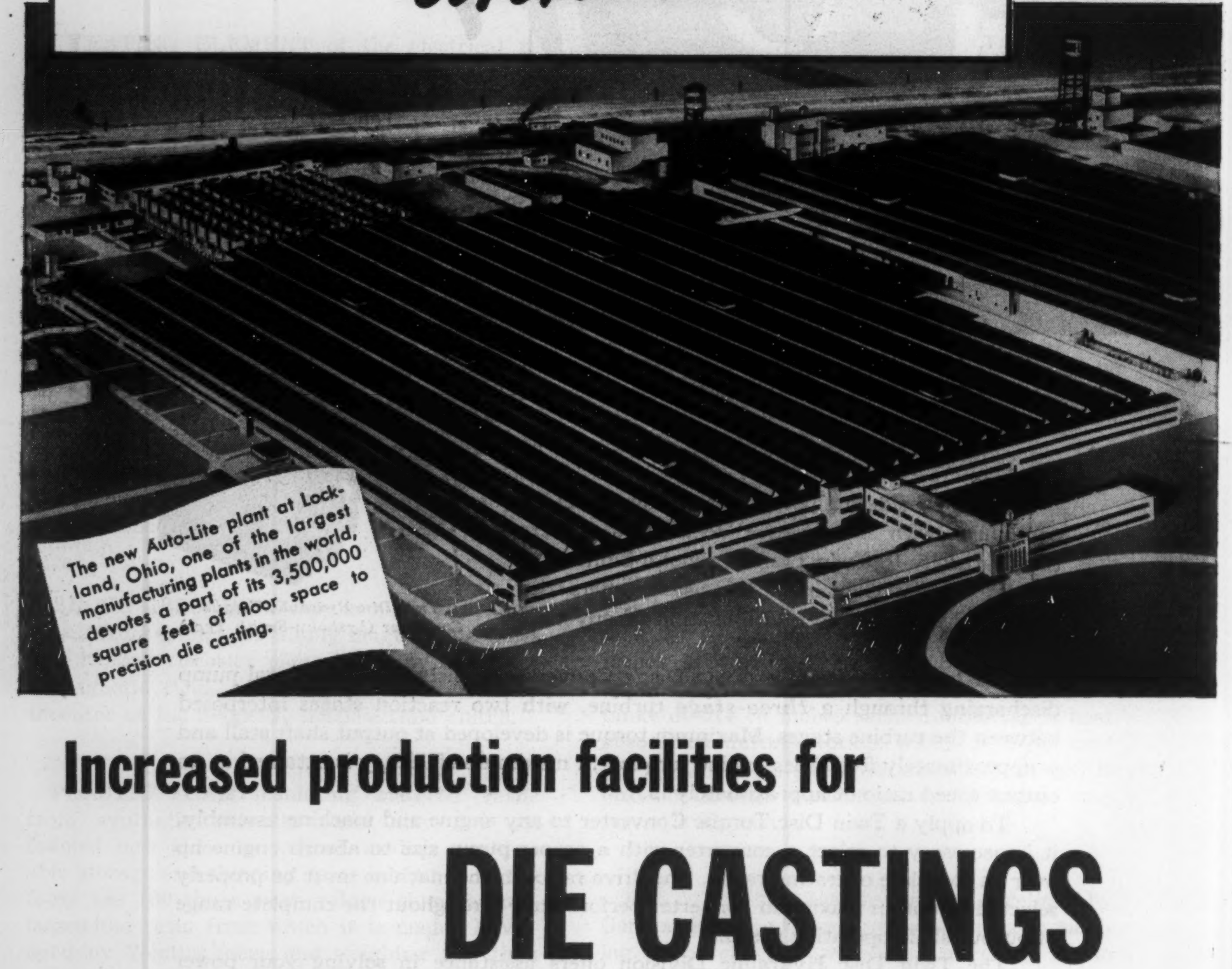
Tractor Clutch

Marine Gear

SPECIALISTS IN INDUSTRIAL CLUTCHES SINCE 1918

AUTO-LITE *announces...*

Tune in "Suspense!"—CBS Radio Network Thursdays, CBS Television Tuesdays



The new Auto-Lite plant at Lockland, Ohio, one of the largest manufacturing plants in the world, devotes a part of its 3,500,000 square feet of floor space to precision die casting.

Increased production facilities for DIE CASTINGS

● **Here is important news for everyone who has need of the accurate, reliable die castings made possible with the famous Auto-Lite "controlled metals" processes. The opening of the great new Lockland plant of Auto-Lite, combined with the enlarged facilities at Woodstock, Illinois, greatly increases Auto-Lite's ability to furnish the high quality die castings for which the Auto-Lite name is known wherever die castings are used. We invite your inquiries.**

THE ELECTRIC AUTO-LITE COMPANY
Die Casting Division, Woodstock, Illinois

600 S. Michigan Avenue
Chicago 5, Illinois

723 New Center Bldg.
Detroit 2, Michigan

AUTO-LITE MEANS PRECISION MANUFACTURING

MAY, 1949

MACHINE DESIGN
A PENTON PUBLICATION

Designing for Today's Needs

LAMBASTING what he terms "Those Big Fat Cars" a writer in the April issue of *Harper's Magazine* takes several cracks at automotive designers for their seeming failure to gage the motoring public's wants and needs. Some of his criticisms are very much to the point, others are matters of opinion. A few, however, exhibit a natural impatience at the apparent slowness with which ideas from foreign countries, or new ideas developed here, are finding their way into today's designs.

Rear-engine drives, torsion-bar springs, and the Bureau of Standards clutch are cited as typical developments which, it would appear, only lack of initiative on the part of manufacturers is withholding from the American public. For example, the impression is created that the Bureau of Standards clutch is simple, inexpensive and smooth running with none of the disadvantages of fluid drives. Elsewhere in the present issue of MACHINE DESIGN, however, there appears an article on this clutch from which the reader may judge for himself the state of perfection attained by present-day experimental models.

It takes little imagination to picture the justifiable howls of protest which would arise if some overenthusiastic manufacturer were to incorporate an imperfectly developed clutch design in a production car. Commentators would vie with each other in denouncing the reckless irresponsibility of engineers who use the public as guinea pigs on which to try out their hare-brained schemes. Machine designers long ago learned that experiment, development, and testing take years of intensive effort and must be done largely at the manufacturer's expense, not the user's.

In criticising the general trend of passenger car design in this country Mr. Sinks, author of the article, is on sounder ground. It must be admitted that compactness, economy, and convenience have been sacrificed for a big, expense "package," leaving the buyer with a relatively limited range of sizes and designs from which to choose.

Blaming the sales organization rather than the engineers for the current situation, Mr. Sinks points out that what engineers need is "an opportunity to build the sort of car that their good sense must tell them would fit the needs of today." This quotation might well serve to define the climate which all designers need if they are to function effectively. Machine designers must continue to oppose strenuously any efforts on the part of others to compel them to compromise the principles of good design, whether these efforts take the form of pressure for new, untried ideas or for unsound designs to fit an unrealistic sales pattern.

Colin Carmichael

EDITOR

Contin

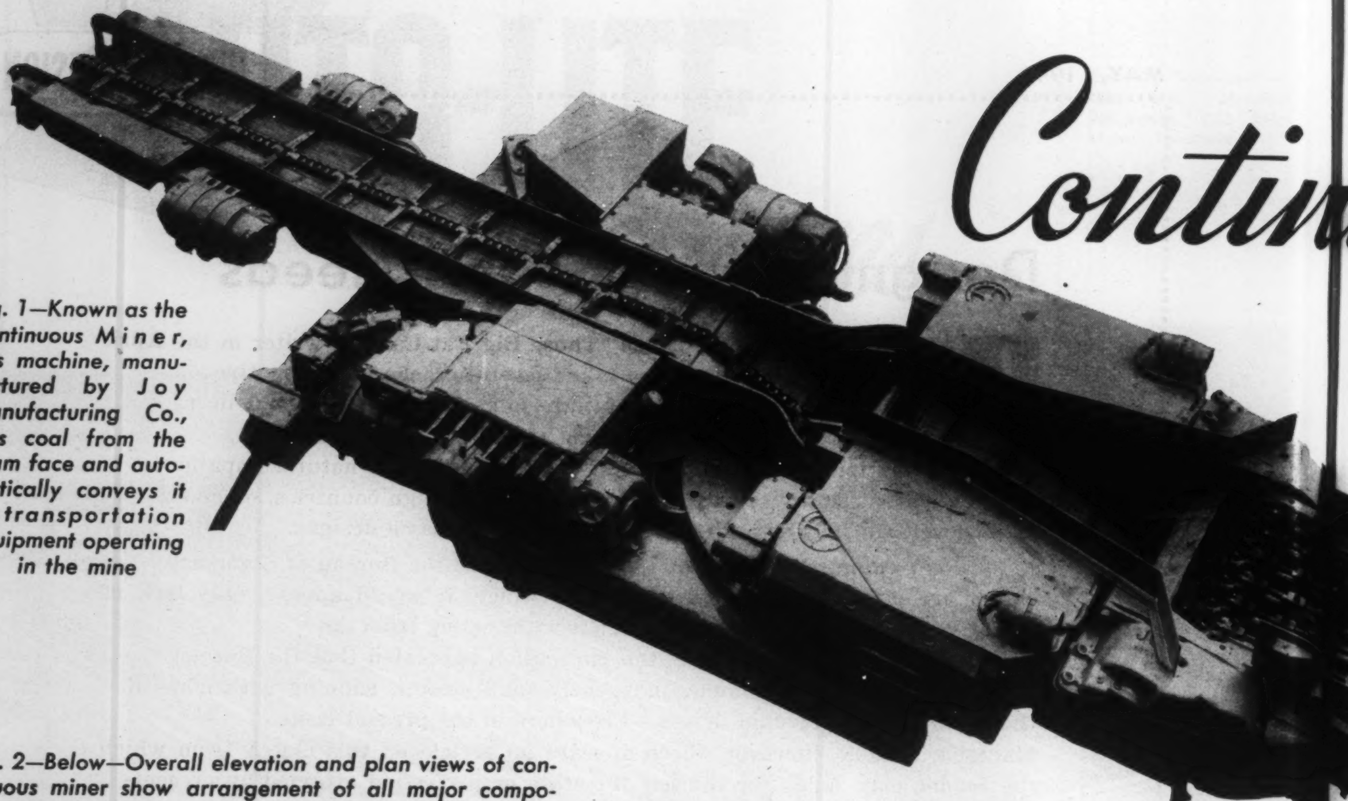
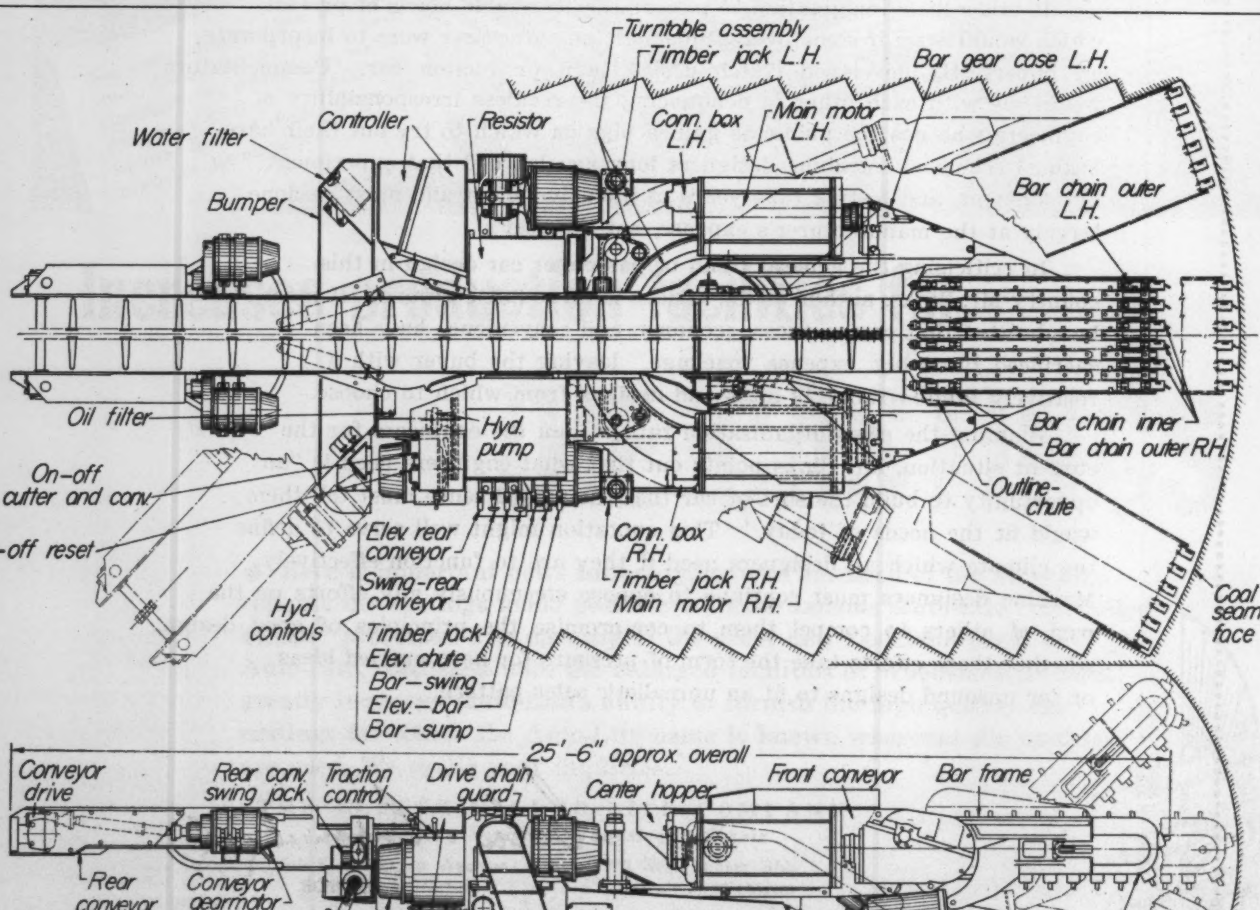


Fig. 1—Known as the Continuous Miner, this machine, manufactured by Joy Manufacturing Co., rips coal from the seam face and automatically conveys it to transportation equipment operating in the mine

Fig. 2—Below—Overall elevation and plan views of continuous miner show arrangement of all major components and manner in which machine operates in mine


Turntable assembly
Timber jack L.H.
Bar gear case L.H.
Water filter
Controller
Resistor
Conn. box L.H.
Main motor L.H.
Bumper
Bar chain outer L.H.
Oil filter
Hyd. pump
Bar chain inner
Bar chain outer R.H.
On-off cutter and conv.
Outline-chute
Safe-off reset
Elev. rear conveyor
Conn. box R.H.
Swing-rear conveyor
Timber jack R.H.
Main motor R.H.
Coal seam face
Hyd. controls
Timber jack
Elev. chute
Bar-swing
Elev.-bar
Bar-sump
25'-6" approx. overall
Conveyor drive
Rear conv. swing jack
Traction control
Drive chain guard
Center hopper
Front conveyor
Bar frame
Rear conveyor
Conveyor gearmotor
Water inlet
Trailing cable
Hyd. pump motor
Master switch
Crawler assembly
Chute jack
Bar elev. jack
Chute
Bar idler head

uous Miner

By Richard K. Lotz
Associate Editor, Machine Design

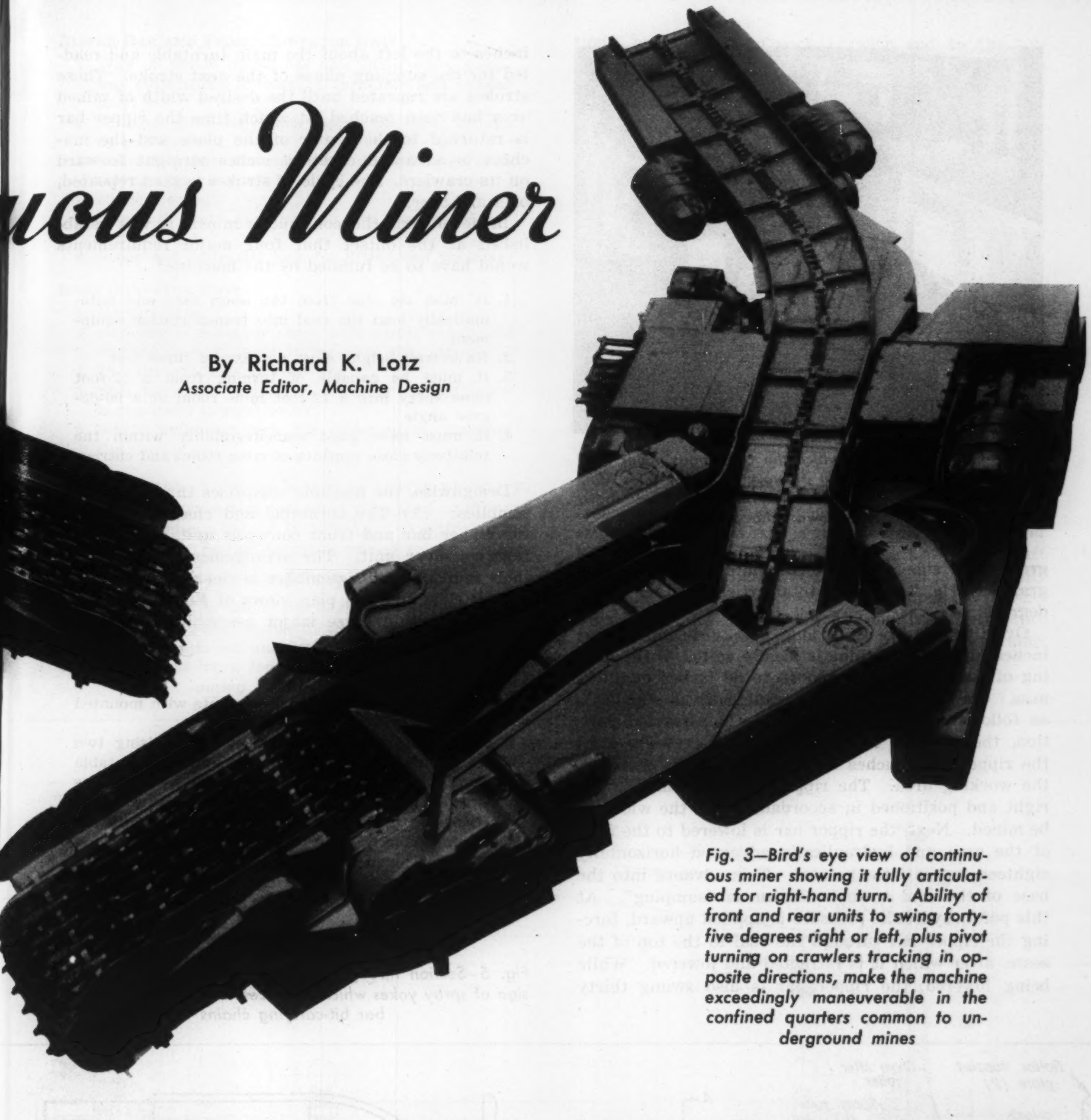


Fig. 3—Bird's eye view of continuous miner showing it fully articulated for right-hand turn. Ability of front and rear units to swing forty-five degrees right or left, plus pivot turning on crawlers tracking in opposite directions, make the machine exceedingly maneuverable in the confined quarters common to underground mines

ON December 14 of last year, representatives of the press and a group of independent engineers gathered in an underground coal mine near Finleyville, Pa., to witness the demonstration of a new mining machine. What they saw was a machine which, in lieu of blasting, cutting and drilling, literally ripped coal from the seam face by the action of 120 carbide-tipped bits mounted on electrically powered chains. But that wasn't all; for the machine not only tore the coal from the seam, but conveyed it automatically into transportation equipment for removal from the mine.

Known as the Joy Continuous Miner, *Fig.* 1, this new machine is the latest of a long line of developments brought to the coal industry by the Joy Manufacturing Co. It culminates over eight years of concerted effort on the part of the engineers and executives of that company. In essence, it comprises a ripper bar mounted on an articulated frame in which power-driven conveyors and a hopper are located. The ripper bar tears the coal from the face and discharges it into a front or intermediate conveyor which feeds it into the centrally located hopper (see *Figs.* 2 and 3). From this point the coal is picked up by the rear conveyor and carried back (*Fig.* 4) to the transportation means. Both conveyors and the ripper bar unit are mounted on a frame which carries the auxiliary equipment and is in turn mounted on crawlers. Ripper bar and rear conveyor each can be swung horizontally through an arc of 45 de-

Fig. 4—Conditions under which the continuous miner must operate. This shot shows it at work in the Mathies Mine of Pittsburgh Coal Co., near Finleyville, Pa. View shows flow of coal toward hopper car

grees each side of center, providing, as the photograph of *Fig.* 3 shows, a total articulation arc of 90 degrees.

Over twenty-five feet long, yet only thirty-four inches high, the machine is ideally suited to the mining of seams ranging from 40 to 60 inches in thickness. Its operation, shown graphically in *Fig.* 2, is as follows: With the ripper bar in retracted position, the machine is advanced on its crawlers until the ripper bar touches the coal face in the center of the working area. The ripper is then swung to the right and positioned in accordance with the width to be mined. Next, the ripper bar is lowered to the floor of the area and hydraulically advanced horizontally eighteen inches into the coal. This advance into the base of the coal seam is known as "sumping". At this point, hydraulic pressure is applied upward, forcing the ripper bar through the coal to the top of the seam, after which it is retracted and lowered. While being lowered, the ripper bar is also swung thirty inches to the left about the main turntable and readied for the sumping phase of the next stroke. These strokes are repeated until the desired width of mined area has been reached, at which time the ripper bar is returned to the center of the place and the machine is advanced eighteen inches straight forward on its crawlers. The cycle of strokes is then repeated, over and over.

In developing the continuous miner, it was established at the outset that four major requirements would have to be fulfilled by the machine:

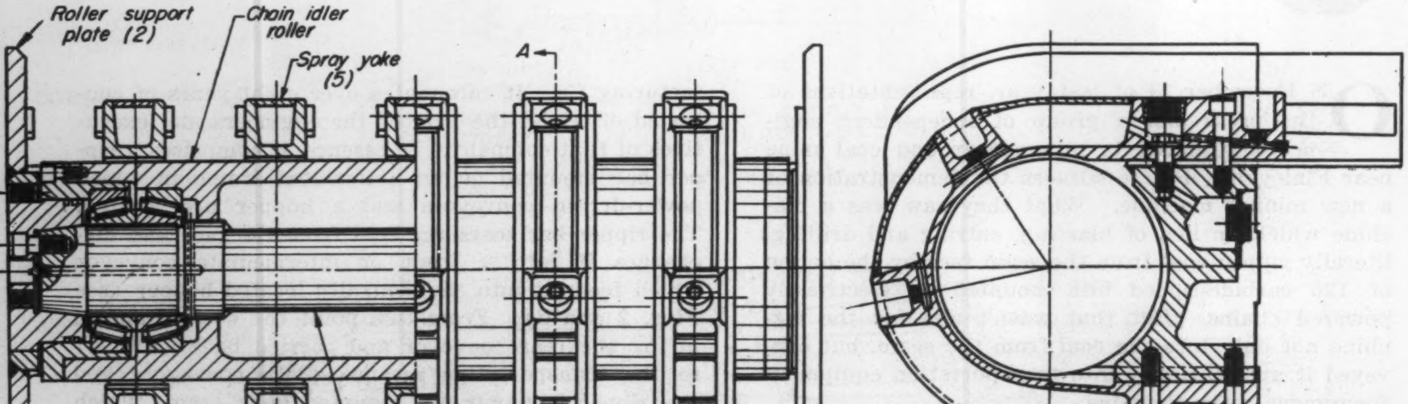
1. It must rip coal from the seam face and automatically load the coal into transportation equipment
2. Its overall height must not exceed three feet
3. It must be capable of turning from a 12-foot mine entry into a 12-foot mine room at a 90-degree angle
4. It must have good maneuverability within the relatively close confines of mine rooms and entries.

Designwise, the machine comprises three major assemblies: (1) The turntable and chassis unit, (2) the ripper bar and front conveyor unit, and (3) the rear conveyor unit. The arrangement of these and their individual subassemblies is clearly shown in the overall elevation and plan views of *Fig.* 2. Subunits contained within these major assemblies are as follows:

TURNTABLE AND CHASSIS UNIT:

1. Upper and lower turntable elements with mounted ripper-bar (main) drive motors
2. Ripper-bar swing driving means, comprising two hydraulic jacks actuating the upper turntable element through link chains running over sheaves
3. Crawler treads, frame, mechanism and drive motor
4. Hydraulic gear-pump motor, pump, sump and valving panel
5. Electrical controller
6. Way for "sumping" the ripper bar unit. This is part of the upper turntable.

Fig. 5—Section through ripper-bar idler roller shows design of spray yokes which are located between the ripper-bar bit-carrying chains



RIPPER BAR AND FRONT CONVEYOR UNIT:

1. Way on which ripper bar unit slides when sumping (this slides in way of turntable and chassis unit)
2. Trunion pivot on which ripper bar unit swings up and down
3. Reduction units for ripper bar drive (one on each side of ripper bar unit)
4. Ripper bar unit
5. Hydraulic jacks for elevating and lowering of ripper bar unit
6. Scoop and hydraulic jack for lifting and lowering.

REAR CONVEYOR UNIT:

1. Hopper base
2. Articulated conveyor chain with cantilever flights
3. Flexible trough (uses spring-steel side plates)
4. Two drive motors for conveyor
5. Two hydraulic jacks for swinging the conveyor horizontally to right or left
6. Single hydraulic jack for elevating or lowering the conveyor.

Because the explosion hazard is always present in mines due to gases and coal dust, electrical equipment in the continuous miner is held to a practical minimum. Electric motor drives, confined to rotary motions, are applied to each crawler and to the hydraulic gear pump; two motors drive the rear conveyor, and two others drive the ripper-bar chains. Gear reducers selected for use with all electric motor drives, except the traction drives, are Cone-Drive units because they offer the greatest power transmitting capacity in the confined space available.

All straight-line motions in the machine are produced by hydraulic jacks. Thus, hydraulic power is used to position the ripper bar and move it through the various phases of its cycle, including advancing, elevating, retracting, lowering, and swinging. Hydraulic power also serves to lift the cleanup chute, lift and swing the rear conveyor, and elevate timbering jacks which are supplied as auxiliary equipment.

Thirty inches wide, the ripper bar is equipped with six special link chains, each mounting twenty replaceable carbide-tipped bits. Each chain is driven by a separate sprocket on a splined driveshaft powered at each end from a gear reducer which, of course, advances and retracts with the ripper head. At the front end of the ripper head, the chains run over a smooth idler roll which is mounted on tapered roller bearings at each of its ends, *Fig.* 5. The roller shaft is supported at its ends in a yoke which is adjustably attached at the front end of the ripper-bar frame. This idler yoke is guided in the bar frame structure on two tubular members, welded to the yoke frame,

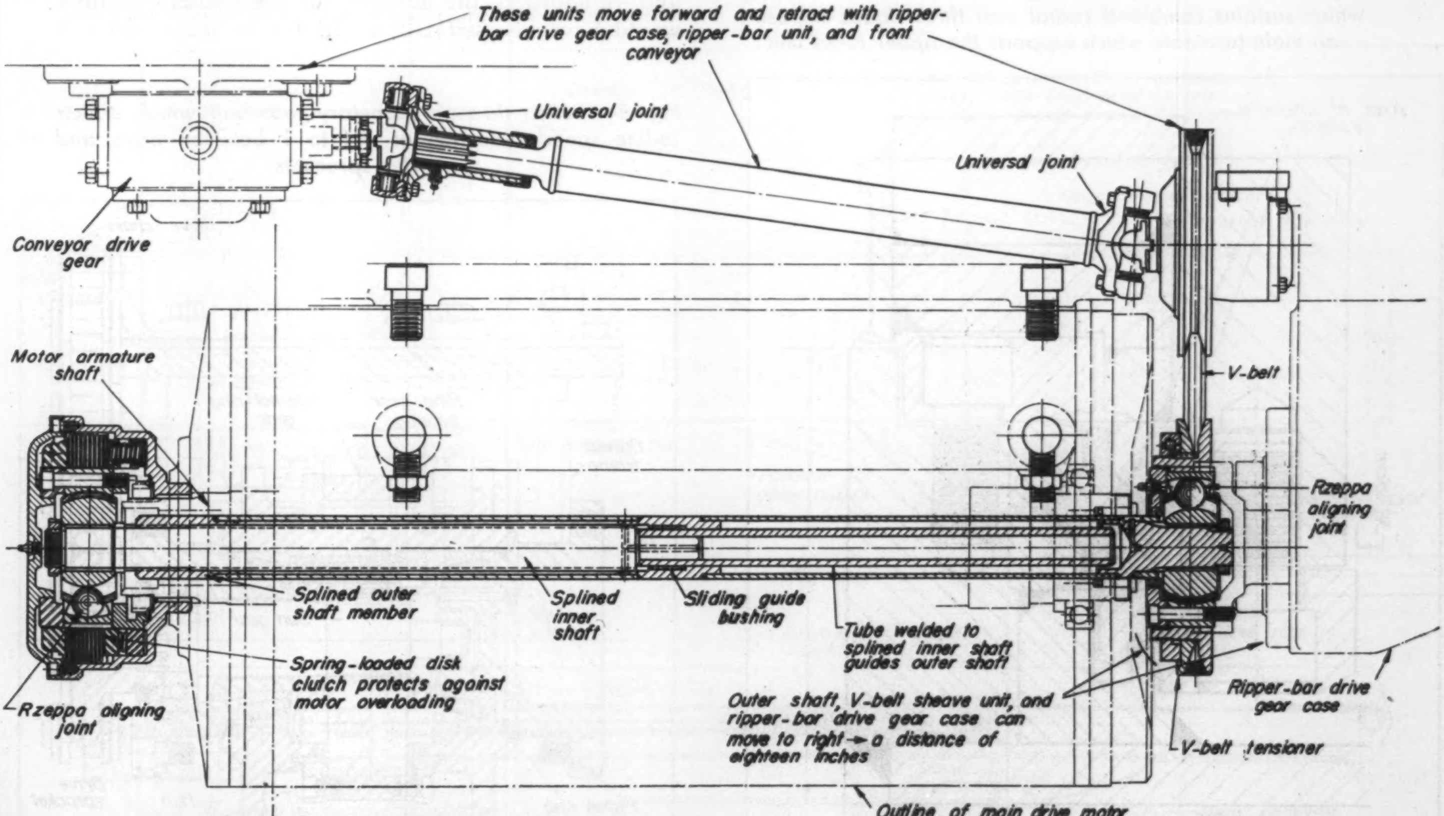


Fig. 6—Telescoping shaft transmits power from special water-cooled electric motor through spring-loaded disk clutch and Rzeppa self-aligning joints to ripper bar gearcase which must move forward and back eighteen inches during mining operation

These units move forward and retract with ripper-bar drive gear case, ripper-bar unit, and front conveyor
Universal joint
Universal joint
Conveyor drive gear
Motor armature shaft
V-belt
Rzeppa aligning joint
Splined outer shaft member
Splined inner shaft
Sliding guide bushing
Tube welded to splined inner shaft guides outer shaft
Spring-loaded disk clutch protects against motor overloading
Rzeppa aligning joint
Outer shaft, V-belt sheave unit, and ripper-bar drive gear case can move to right → a distance of eighteen inches
Ripper-bar drive gear case
V-belt tensioner
Outline of main drive motor

which slide in two mating cylindrical guides in the bar frame. The tubular yoke guides are threaded on their inner diameters to accommodate adjusting screws, which, acting against the bar frame guide members, provide for adjustment of the idler roller to maintain tension in the ripper chains.

Encircling the idler roller and located between the chains is a series of five hollow yokes, each of which has three spray nozzles recessed in it. The function of these yokes is to convey water at line pressure to the nozzles which emit a spray whenever the ripper bar is operating and thus wet down the dust created as the coal is ripped from the seam face. Water is fed into each of the yokes from a transverse chamber in the idler frame, connected to the water supply by flexible hoses.

Power is supplied to each of the ripper-bar gear reducers by a specially designed electric motor rated at 65 continuous horsepower. Since both gear reducers power a common driveshaft, a total of 130 horsepower are available for driving the ripper chains. As *Fig.* 6 shows, this power is transmitted direct from the motor armatures through spring-loaded multiple-disk clutches which serve to protect the driven units against overloads.

Because of space limitations, it was necessary that the ripper-chain drive motors be mounted on the chassis unit rather than on the ripper bar assembly. However, it will be recalled that the ripper bar is required to sump or move forward horizontally a distance of eighteen inches when the machine is attacking the seam. While telescoping shafts are commonly used to permit this type of action, the manner in which such shafts are used in this instance is somewhat novel. To conserve space, they are located inside the motors. Referring again to *Fig.* 6, it will be noted that the inner disks of the clutch are splined to the outside of a Rzeppa self-aligning type joint. The inside member of this joint is splined to the inner telescoping shaft which is splined about half of its length, the other half comprising a guide or pilot for the outer telescoping shaft.

Built up of seamless steel tubes welded together, the outer telescoping shaft carries a short internal spline at the clutch end and a solid steel stub at the other or gearcase end which is in turn connected to the gearcase drive through another Rzeppa joint. A bronze bushing, pressed into the outer telescoping shaft at about its midpoint, rides over the pilot or guide portion of the inner shaft. Thus an effective slide-bearing length of about eighteeen inches is maintained between the internal spline of the outer shaft and its bronze bushing.

A V-belt take-off from the right-side ripper bar motor drives the front conveyor. Space limitations made it necessary that the driveshaft from the V-belt jackshaft to the conveyor-shaft gearcase be set at an angle. One way of effecting this drive would have been, of course, to utilize bevel gears. However, these would have been comparatively expensive and, in addition, the accuracy of positioning required would have necessitated machining of many affected

Fig. 7—Section through Messinger "X" type roller bearing which sustains combined radial and thrust loads imposed on main turntable which supports the ripper head unit

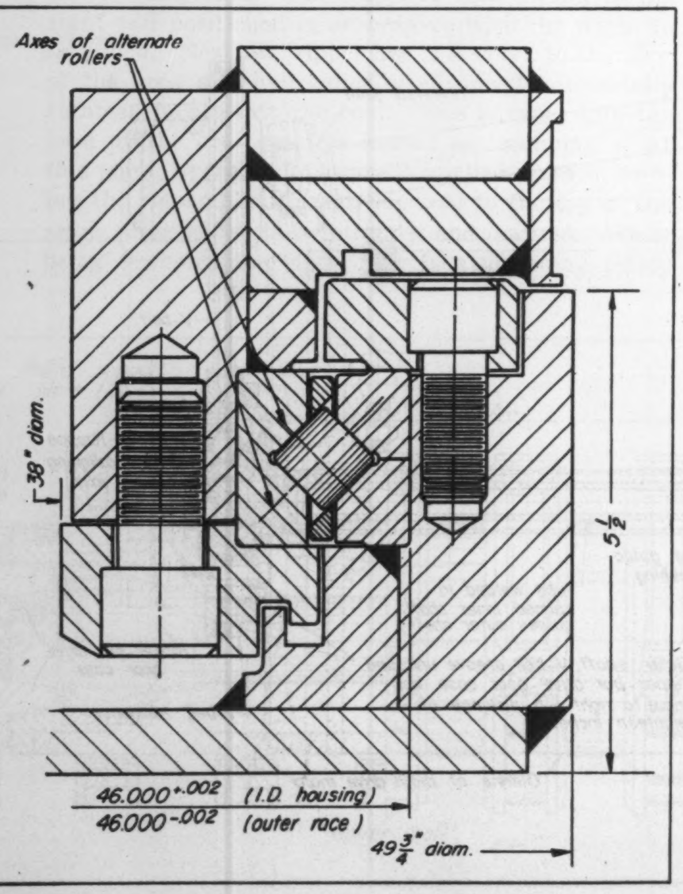
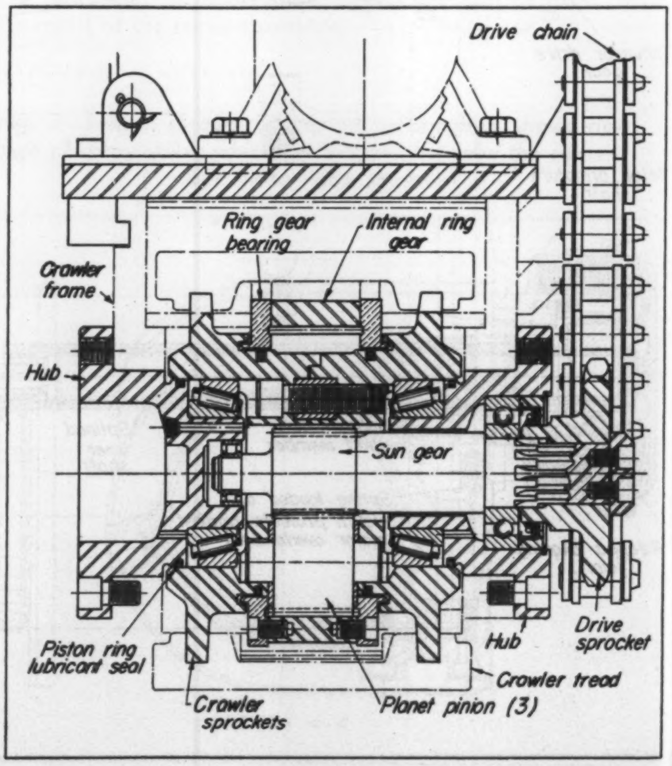


Fig. 8—Section through planetary-gear unit which effects in-line speed reduction of 4.4 to 1 between drive and crawler sprockets



parts to close tolerances. Standard stock universal joints were used instead. They are readily available, relatively inexpensive, and permit satisfactory assembly without the need for machining or positioning the related units to close tolerances.

It was during the last war that an extremely useful and reliable type of combination radial-thrust bearing—the Messinger "X" bearing—saw increasing usage in many machine-gun and antiaircraft gun turrets. Loading on the main turntable of the continuous miner is quite similar to that encountered in large gun turrets, and so the same type of bearing has been employed. As *Fig.* 7 shows, it consists of a series of hardened steel rollers, spaced by a cage, operating in circular V-shaped races. Set at an angle of forty-five degrees, the roller axes are alternately positioned at right angles to each other so that the radial loading is equally divided over the roller bearing surfaces. As will be apparent, in this type of bearing it is required that the lengths of the rollers be slightly less than their diameters.

Crawler Drive Posed Problem

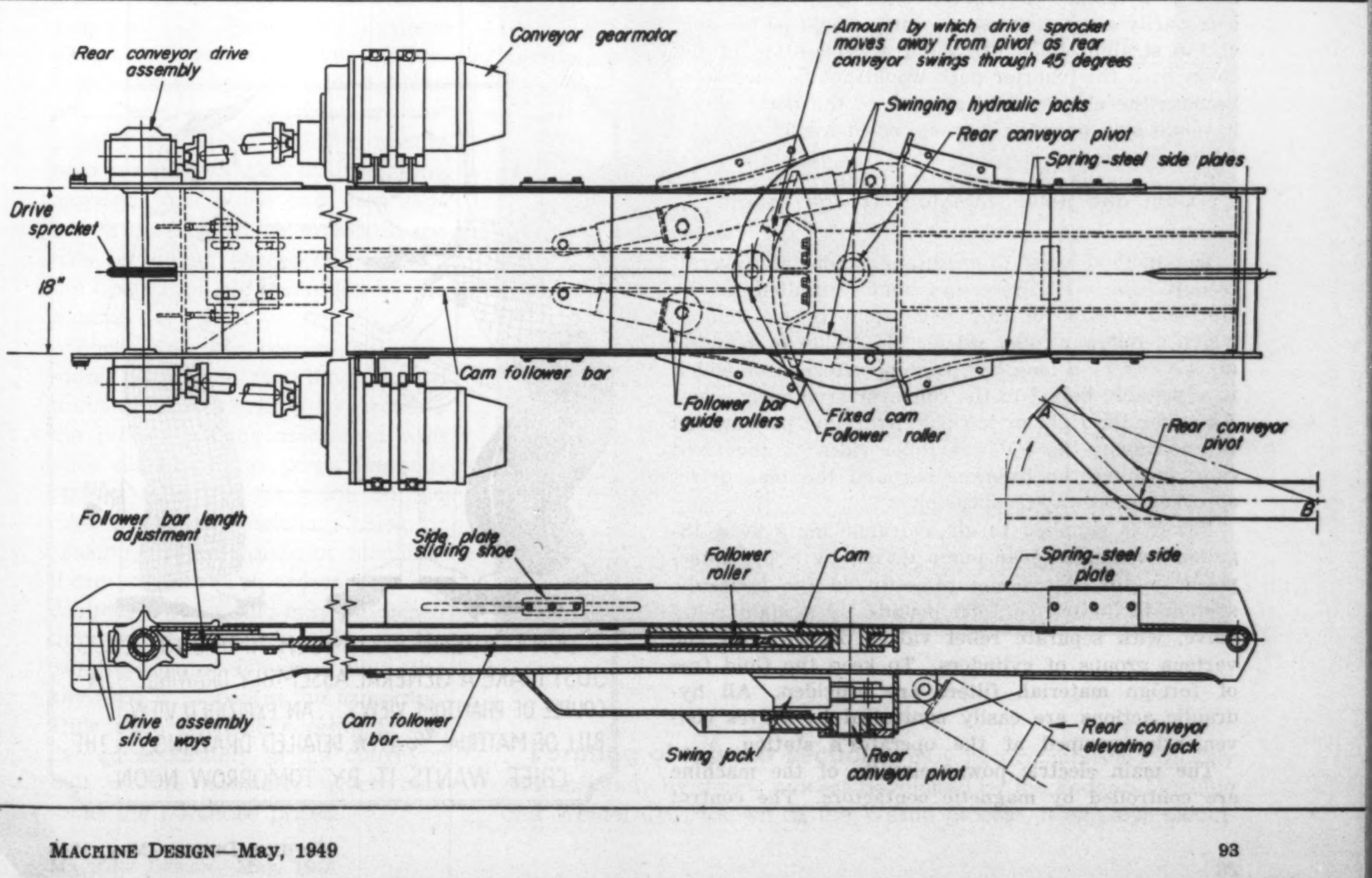
One of the most interesting design problems encountered during development of the machine concerned the method for driving the crawlers on which the entire machine travels. This drive is by means of roller chain from a gear reducer. While it might seem that the simplest way of providing the driving torque required at the tread sprockets would be to effect full speed reduction at the motor end of the drive, such a procedure is not actually feasible.

As will be apparent, the roller chain sprocket must be smaller in diameter than the crawler sprocket. This means that if the connection between these two sprockets were solid, the drive chain would have to be stronger than the crawler tread chain inasmuch as it operates over a smaller sprocket. That is precisely where the trouble arises, because roller chain which is large enough and strong enough to sustain loading of the magnitude involved will not operate satisfactorily over a sprocket as small in diameter as the one here required.

If, however, a final speed reduction can be effected between the drive and crawler sprockets, proportionately lower loading will be imposed on the drive chain, which then can be of a size such as will operate properly over the small sprocket provided. Accomplishing this in the traction drive of the continuous miner involved the development of a planetary-gear reduction unit the design of which is clearly shown in the sectional view of *Fig.* 8.

It will be seen that the double sprocket is made in two halves, piloted and bolted together. These halves are machined out to receive three planet pinions which rotate on needle bearings. Also part of this assembly is the internal ring gear, to both sides of which bronze rings are fastened which serve as sealing members between the gear and sprockets. The sprocket unit rotates relative to the hubs and internal

Fig. 9—Drawing shows how cam and follower arrangement is employed in rear conveyor to maintain constant chain tautness as conveyor swings to right or left of center


Rear conveyor drive assembly
Conveyor gearmotor
Amount by which drive sprocket moves away from pivot as rear conveyor swings through 45 degrees
Swinging hydraulic jacks
Rear conveyor pivot
Spring-steel side plates
Drive sprocket
18"
Cam follower bar
Follower bar guide rollers
Fixed cam
Follower roller
A
Rear conveyor pivot
D
B
Follower bar length adjustment
Side plate sliding shoe
Follower roller
Cam
Spring-steel side plate
Drive assembly slide ways
Cam follower bar
Swing jack
Rear conveyor pivot
Rear conveyor elevating jack

ring gear on Timken tapered-roller bearings, while the sun-gear shaft, which is direct driven by the drive-chain sprocket, rotates on one roller and one ball bearing mounted in the hubs. As can be seen, the hubs are bolted to the crawler frame. To lock the ring gear against rotation a long anchor bar is fastened at one end to lugs on the ring gear, while a slot in its opposite end fits over a pin which is fastened to the frame. This arrangement permits the ring gear to center itself on its driving contacts with the planet pinions. To insure absolutely equal tooth loading on all of the three planet pinions the anchor bar would have to be of infinite length. However, the available length reduces the inequality of tooth load to a reasonable value. Speed reduction between drive and crawler sprockets is 4.4 to 1. The entire gear chamber is filled with grease, sealed in by piston rings as shown in the sectional view.

As has been indicated, the rear conveyor of the machine can be swung horizontally through forty-five degrees each side of center and in addition, the conveyor can be raised or lowered. Both of these motions are powered hydraulically. Two jacks are used alternately for swinging the conveyor and one is employed for raising and lowering. Arrangement of these jacks and other units involved in the swinging action is shown in *Fig.* 9.

Inasmuch as the conveyor chain is universal—that is, it can flex laterally as well as vertically—it is a simple matter to guide the chain over the varying radius at the swing pivot by means of flexible spring-steel side plates. However, the path taken by the chain as its trough swings, shortens in proportion to the amount of swing. As the diagrammatic sketch in *Fig.* 9 shows, the curved path from B to A is necessarily shorter than one which would be the sum of the straight lines BO and OA. Operation of the chain over this shorter path would not be successful because the chain would slacken to the point where it would skip over the drive-sprocket teeth.

Cam and Roller Maintain Trough Length

The method used to maintain a constant overall trough length is direct and simple. Bolted to the stationary frame of the conveyor is a cam against which a follower roller rides. This roller is mounted at one end of a long bar, the opposite end of which is adjustably bolted to the conveyor-drive gear cases. As either the right or left-side hydraulic jack swings the conveyor, the follower roller rides on the fixed cam, pushing the follower bar and the rear drive-sprocket unit away from the pivot.

Power is supplied to all hydraulic units by a 15-gallon-per-minute gear pump driven by a 7½-horsepower motor. Maximum pressure on the hydraulic system is limited to 1500 pounds by a main relief valve, with separate relief valves provided for the various groups of cylinders. To keep the fluid free of foreign material, filters are provided. All hydraulic actions are easily controlled by valves conveniently grouped at the operator's station.

The main electric power circuits of the machine are controlled by magnetic contactors. The control circuits are actuated by sealed mercury timing tubes which are operated by the magnetic flux of the main contactors. This provides a simplified control system free of the difficulties usually caused by dust and dirt. All electrical parts are sealed in explosion-proof steel compartments and all wiring has flame-resistant insulation. The main electrical controls are grouped alongside the hydraulic controls.

They Say . . .

"If the profits are doubled because of the system, most of the increases should go to the men who double the profits. These people will be the workers, the engineers, the customers and the management. There is usually no evidence that the stockholder did much to increase the profit. His proper share therefore is small."—JAMES F. LINCOLN, *President, Lincoln Electric Co.*

"Why don't we have aluminum cars today? Until recently the major obstacle was cost. There is a far greater need for lower cost than for lighter weight. As a result steel has remained undisputed king for these many years. Cost is still a major stumbling block in the widespread substitution of aluminum for steel in automobile construction."—HAROLD T. YOUNGREN, *Ford Motor Co.*

"Real progress in engineering often results from projecting practice ahead of theory and then bringing theory up to date."—LAUREN GUTH, *supervisor of Creative Engineering Program, General Electric Co.*

"DON'T SPEND TOO MUCH TIME ON IT ED . . . JUST MAKE A GENERAL ASSEMBLY DRAWING . . . A COUPLE OF PHANTOM VIEWS . . . AN EXPLODED VIEW . . . BILL OF MATERIAL AND A FEW DETAILED DRAWINGS . . . THE CHIEF WANTS IT BY TOMORROW NOON."

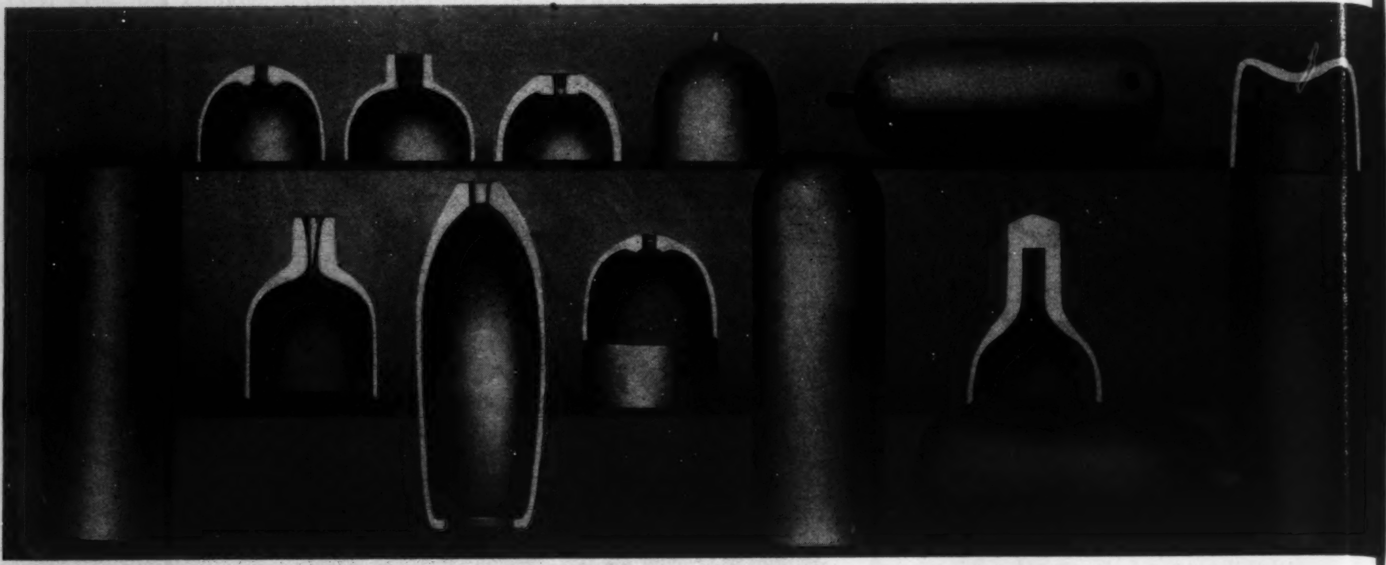
Scanning the field for Ideas

Automatic equipment now aids the grocery purchaser, right, making more efficient operation of the store and facilitating the task of purchasing. The system involves a "key" or small package of paper tape for the customer, a display of all merchandise, a printing and hole punching unit associated with each display group, a translator machine to interpret orders on the key, a package dispensing system, and a conveyor belt for delivery of purchases to the customer.

Invented by Clarence Saunders, president of Automatic Systems Corp., the system, known as Keedoozle, is in operation in a Memphis, Tenn. store. Articles are dispensed at the rate of 240 a minute onto a conveyor belt by first being dropped to a baffle and then sliding to the belt which travels at the rate of 10 feet per second. All of the operations are controlled by the punched key tape.

Each customer carries his individual key tape, recording desired purchases on the tape by pressing the proper buttons associated with each display. This prints the purchased item and its price on the tape as well as punching holes for sensing by the translator machine. If any purchases so ordered are not desired, a pencil line may be drawn through the order, cancelling it. No purchases are delivered until the key tape is placed in the translator. Thus each customer's order is delivered separately to the conveyor belt by the translator which also totals the purchase prices.

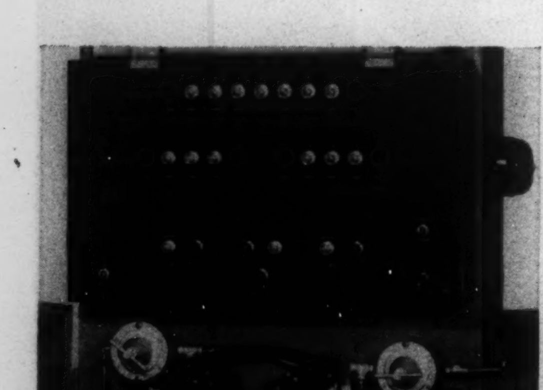
Forming of tubular sections may be accomplished quickly and uniformly by a new process developed by the Federal Machine and Welder Co. Known as the Westin process, it employs electri-



cal current and pressure and results in savings both in time and material. The machine used employs a heating transformer, split dies, mechanism for rotating the tube, and a method for feeding the tube into the die cavity. The two halves of the die are insulated from each other, each being connected to one side of the transformer.

As the tube to be formed enters the die, current flows from one die segment through the tube and back through the other segment. Electrical resistance of the tube to the flow of current causes it to heat rapidly and, as it is fed into the die under pressure, it assumes the shape of the die cavity. Some extruding operations are also possible.

Applications of the method include sealing tube ends, necking down tube sections, upsetting sections of tubing to increase wall thickness, and similar operations Typical cylinders and heads are illustrated above. Speed of the process is limited only by practical mechanical considerations and amount of electric power available. Typical example is bottle necking a $3\frac{1}{2}$-inch OD by $\frac{1}{8}$-inch wall tube. This required six seconds with a peak demand of 160 kva. Metals that have been worked by the process include carbon steels, most alloy steels including stainless, and brass and aluminum.



Checking and classifying pistons for Oldsmobile Rocket engines are accomplished on the machine illustrated below and with its cover open at left. It stamps on the piston the separate classifications based on the pin hole and skirt.

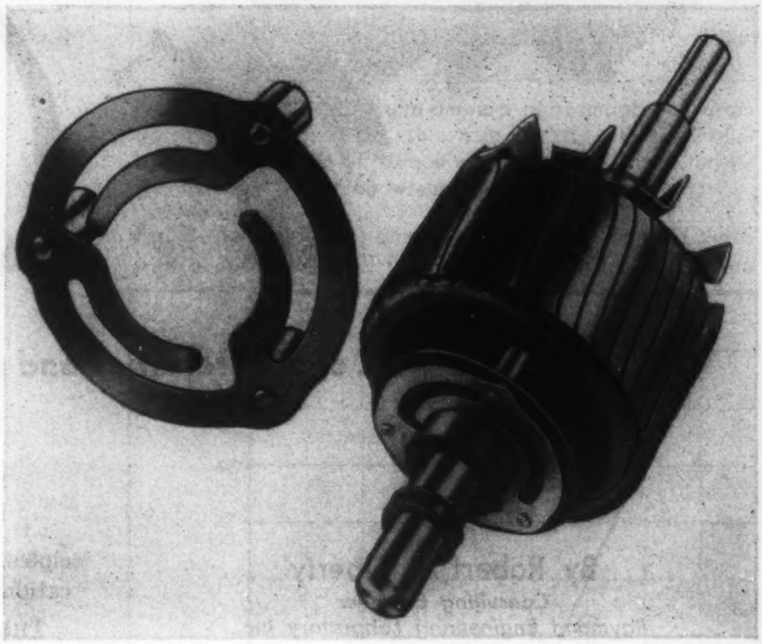
Wichita City Library

Average diameter of the piston pin hole in each bearing is checked by a double column air-jet gage controlling the mechanism which automatically stamps the piston with the proper number for one of four classifications of 0.0001-inch each. If the hole in one side varies sufficiently from the hole in the other side to qualify the piston in two different classifications, the larger will determine which classification is actually stamped on the piston.

Diameter at the bottom of the skirt is checked by a gage which actuates another stamping device, printing a letter to classify each piston in one of eight groups which vary in steps of 0.00025-inch. At the same time a lamp is lit over the correct classification tray into which the piston is to be placed. This light remains on until the next piston to be checked is located in gaging position. Production rate of inspection is between 400 and 600 pistons per hour in this unit designed by the Sheffield Corp.

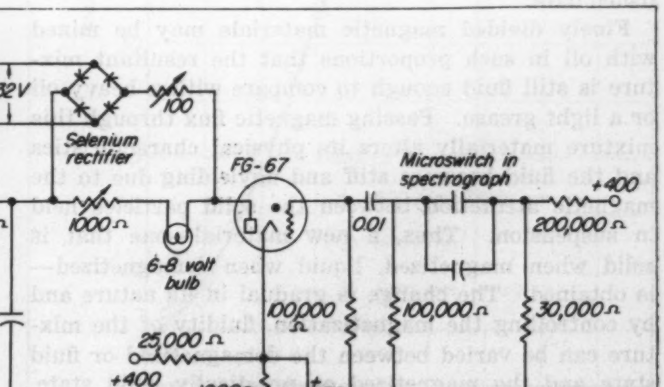
Centrifugal switch shown at right, stamped from spring material, has three weights attached to the rim of the stamped disk. Switching action, which is confined within the disk and fingers, is produced by a torque reaction from centrifugal force acting on the weights. Developed by the Torq Electric Corp. as a starting switch for induction motors, the switch has a snap action for on and off operation. Also shown assembled on a motor rotor, the switch operates at preset speeds, characteristics remaining constant throughout its life.

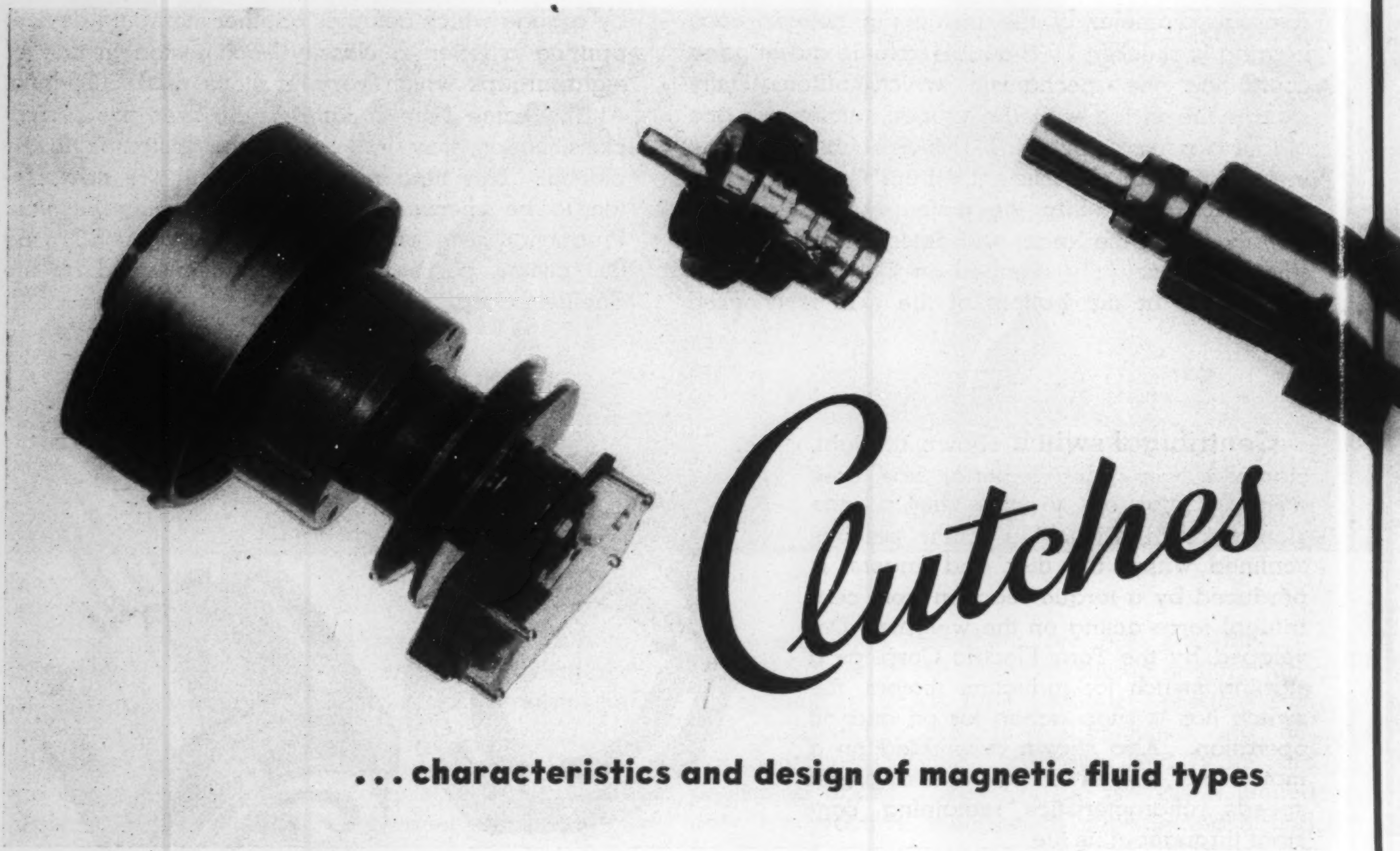
When the motor reaches speed on its starting winding, centrifugal force acting on the switch weights causes the torque reaction on the disk to open the switch contacts. Contrariwise, after the motor speed drops, tension in the disk overcomes the reduced centrifugal force of the weights and the disk snaps back to starting position, there being no "flutter" position on the contacts.



Calibration flasher, design to eliminate variations in the intensity and width of reference lines when spectra are recorded photographically at different speeds, is shown schematically in the circuit diagram at right. Closing of the Microswitch fires the thyratron which discharges a 4 mfd condenser through a small incandescent lamp filament.

Magnitude and duration of the current wave produced by each condenser discharge will be the same regardless of changes in the flashing rate. An increased flashing rate, however, will tend to increase the starting temperature of a lamp filament excited solely by the condenser discharge and increased flash intensities would result. Filament starting temperature is corrected by means of a small direct current provided by the transformer, full-wave rectifier and series resistance in this circuit developed by the Texas Co. Direct-current excitation of the lamp is desirable since flashing will occur at different phases of an alternating-current wave, and reference lines of varying intensity will result.





Clutches

... characteristics and design of magnetic fluid types

By Robert S. Elberty
Consulting Engineer
Raymond Engineering Laboratory Inc.
Middletown, Conn.

MAGNETIC fluid clutches have attracted a great amount of engineering attention since this development was announced by the National Bureau of Standards.* Because this clutch is a new type of electrical device, it might be well, at the risk of some repetition, to review some of the previously published data.

Finely divided magnetic materials may be mixed with oil in such proportions that the resultant mixture is still fluid enough to compare with a heavy oil or a light grease. Passing magnetic flux through this mixture materially alters its physical characteristics and the fluid becomes stiff and unyielding due to the magnetic attraction between the solid particles held in suspension. Thus, a new material—one that is solid when magnetized, liquid when demagnetized—is obtained. The change is gradual in its nature and by controlling the magnetization, fluidity of the mixture can be varied between the demagnetized or fluid state and the magnetized or practically solid state. The controllable nature of the fluid makes it ideally suitable for application to clutching operations. In less than a year since the publication† of these principles, a number of clutch designs, *Fig.* 1, and applications have been made.

THEORY: Magnetic force betwen two poles M and M' separated by a distance r may be expressed by the equation

$$f = \frac{M M'}{r^2} \text{ dynes (cgs units)}$$

If the poles are of equal intensity, M, the equation becomes

$$f = \frac{M^2}{r^2}$$

This theory applies to magnetic clutches of the dry type and to eddy current devices. However, the actual performance of the magnetic fluid clutch does not follow the square law, torque varying directly as the magnetizing ampere turns below magnetic saturation. *Figs.* 2 and 3 are typical examples of this performance characteristic. A theory supporting this performance as determined experimentally might be expressed as follows:

> **The drag in a magnetic fluid is caused by chains or bridges of magnetically saturated magnetic particles, saturation occurring at the time the chain is formed. Additional magnetization cannot increase**

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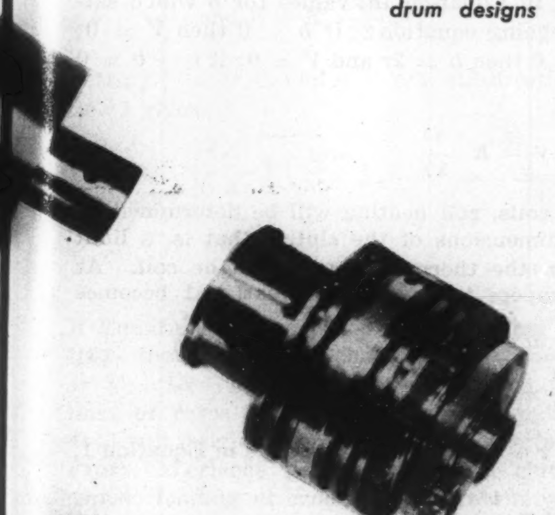
* See MACHINE DESIGN, May, 1948, Page 99.

† *Technical News Bulletin*, The National Bureau of Standards, Vol. 32, No. 5, May, 1948.

Fig. 1—Development models of magnetic fluid clutches. This group shows some of the possibilities of the disk and drum designs



the pull on individual chains, but does increase the number of chains. The pull per chain being a constant value, the total drag is determined by the number of chains which is in turn determined by the total lines of force passing through the magnetic fluid.

Additional experimental data support the foregoing theory. For example, the permeability of an iron-oil mixture is substantially constant over wide limits of magnetization. A loss of oil from the iron-oil mixture decreases the torque obtainable from a clutch. This might be explained in the light of the multiple chain theory, the absence of sufficient lubricant preventing the formation of chains.

Design Considerations

Torque: Drag is proportional to total lines of force through the fluid, and to the number of fluid paths in series. The torque is proportional to the effective diameter of this fluid path.

Summarizing, the best clutch for a given size is that which will put a maximum number of lines of force through the most paths in series at the greatest effective diameter.

Magnetic Circuit: A magnetic circuit should provide the shortest magnetic path around the shortest electrical path. For clutch considerations, it is an easy matter to have a circular coil and a substantially square path for the magnetic flux. *Fig.* 4 shows a general type of magnetic circuit applicable to a clutch design. For small coils, ampere turns is proportional

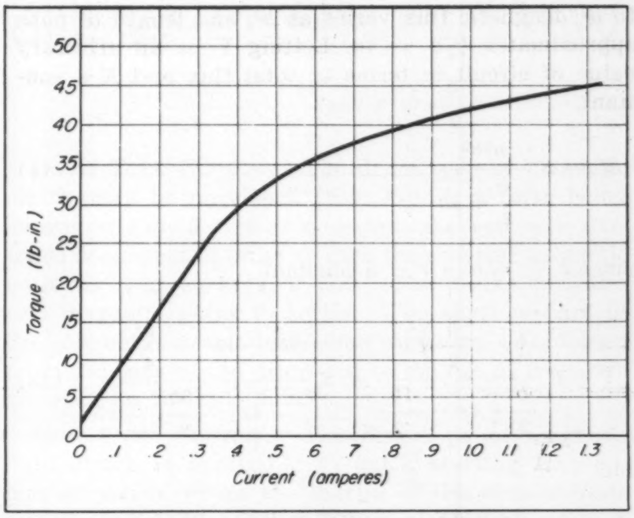
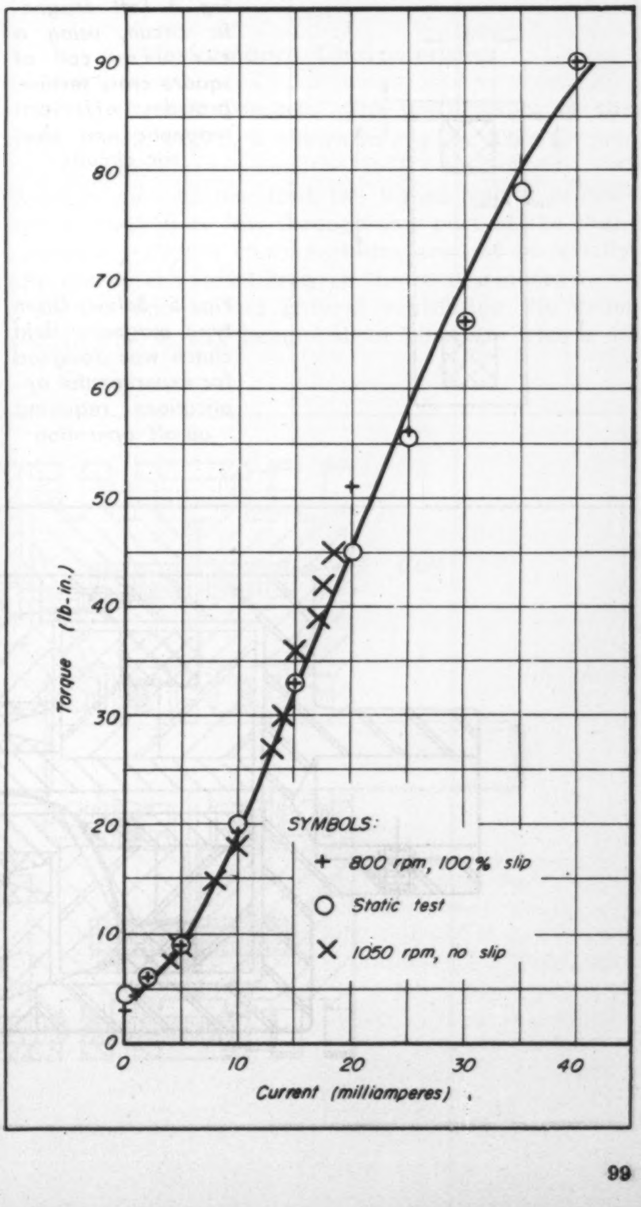


Fig. 2 — Above — Torque-ampere performance of drum clutch. Two-inch clutch, shown in Fig. 5, with a 32-ohm coil develops 42 lb-in. torque at 40 C rise. Characteristic clearly shows the effect of magnetic saturation

Fig. 3—Below—Torque-ampere performance of disk clutch with a 3600-ohm coil. Characteristics practically coincide



to a^2, magnetic flux varies as b^2, and length of path approximates $\frac{1}{2}b + 4a$. Letting V = an arbitrary value of circuit in terms of total flux and K a constant,

$$V = K\frac{a^2b^2}{\frac{b}{2} + 4a} \quad \ldots\ldots\ldots\ldots (1)$$

Since $a + \frac{1}{2}b = r$ = a constant,

$$V = K\frac{\left(r - \frac{b}{2}\right)^2 b^2}{\frac{b}{2} + 4r - \frac{4b}{2}} = K\frac{r^2b^2 - rb^3 + \frac{b^4}{4}}{4r - \frac{3b}{2}} \quad \ldots (1a)$$

and

$$\frac{dV}{db} = K\frac{2r^2b - 3rb^2 + b^3}{4r - \frac{3b}{2}}$$

Letting $dV/db = 0$, then

$$\frac{b(2r^2 - 3rb + b^2)}{4r - \frac{3b}{2}} = 0$$

and

$$b(2r - b)(r - b) = 0$$

Substituting, in Equation 1*a*, values for b which satisfy the foregoing equation: If $b = 0$ then $V = 0$; if $2r - b = 0$ then $b = 2r$ and $V = 0$; if $r - b = 0$ then

$$b = r \text{ and } V = K\frac{r^3}{10} \quad \ldots\ldots\ldots\ldots (2)$$

For large coils, coil heating will be determined by the overall dimensions of the clutch, that is, a limit is reached in the thermal capacity of the coil. At this point ampere turns = a. Equation 1 becomes

$$V = K'\frac{ab^2}{\frac{b}{2} + 4a} \quad \ldots\ldots\ldots\ldots (3)$$

Substituting $r - \frac{1}{2}b$ for a as was done in Equation 1,

$$V = K'\frac{rb^2 - \frac{b^3}{2}}{4r - \frac{3b}{2}} \quad \ldots\ldots\ldots\ldots (3a)$$

$$\frac{dV}{db} = K'\frac{2rb - \frac{3b^2}{2}}{4r - \frac{3b}{2}}$$

Letting $dV/db = 0$, then

$$\frac{2rb - \frac{3b^2}{2}}{4r - \frac{3b}{2}} = 0$$

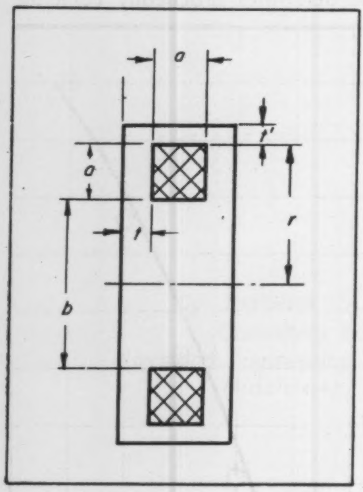


Fig. 4—Left—Magnetic circuit, using a circular coil of square cross section, provides efficient magnetic and electric circuits

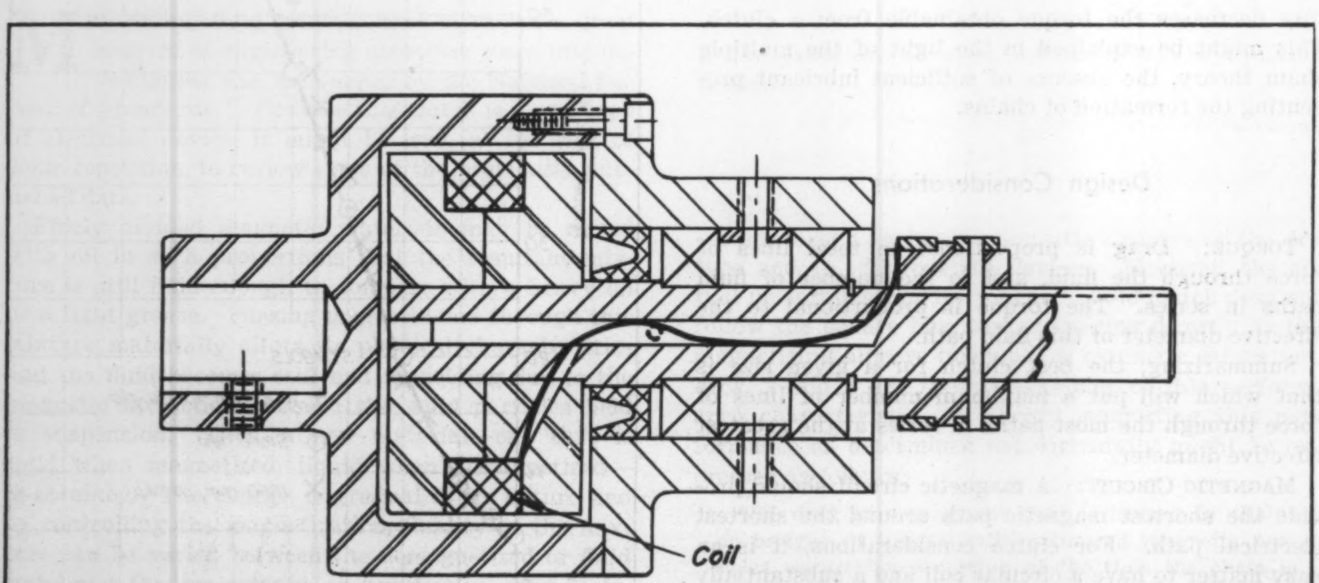


Fig. 5—Below—Drum type magnetic fluid clutch was designed for experimental applications requiring on-off operation

and, after simplifying,

$$b\left(2r-\frac{3b}{2}\right)=0$$

From Equation 3*a*, if $b = 0$ then $V = 0$; if $2r - 3b/2 = 0$ then

$$b=\frac{4r}{3}\text{ and }V=K'\,\frac{8}{27}\,r^2 \quad\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(4)$$

Letting $b = 4r/3$, and $a = r/3$, substitution in Equation 1 gives

$$V=K\,\frac{\left(\dfrac{r^2}{9}\right)\left(\dfrac{16r^2}{9}\right)}{\dfrac{4r}{6}+\dfrac{4r}{3}}=K\,\frac{r^3}{10.1}\quad\ldots\ldots\ldots\ldots(5)$$

If Equation 5 is compared with Equation 2, it is seen that there is little change in V for values of $4r/3 > b > r$. The design objective is to get the most lines of force through the magnetic path and $b = 4r/3$ will provide a greater area of iron in the circuit. From experience gained in several clutch designs, copper loading at moderate saturation values is not excessive for a design proportion of $a = b/4$. Since this proportion provides a small coil, Equation 1 applies rather than Equation 3. Equation 4 may be neglected except for special-purpose magnetic circuits.

The remaining magnetic circuit can now be designed to provide a uniform cross section throughout. The procedure is as follows: Cross section area of center $= \pi b^2/4$ and cross section area of flange $= \pi bt$. Then

$$\pi bt=\frac{\pi b^2}{4}\text{ and }t=\frac{b}{4}$$

Cross section area of outer edge of flange $= 3\pi bt'/2$. Then

$$\frac{3\pi bt'}{2}=\frac{\pi b^2}{4}\text{ and }t'=\frac{b}{6}$$

Drum Type Clutch: The drum type of magnetic clutch may be developed from *Fig.* 4, a form being shown in *Fig.* 5. In this design, the coil was flattened somewhat in order to give the shortest magnetic path for a given area of coil. The design provides two magnetic paths in series. The shaft is part of the magnetic circuit and some clutching is obtained from the ends of the drum due to the use of magnetic material on the side flanges.

Disk Type Clutch: The disk type of magnetic fluid clutch is applicable to quick starting mechanism or servos where the inertia of the disk is quite low in proportion to the torque developed. *Fig.* 6 shows the design of the Raymond Engineering Laboratory 731 clutch. This design provides four magnetic paths in series and a high ratio of torque to driven member inertia is obtained. To reduce losses due to magnetic leakage the spacer between the two sides is nonmagnetic.

Performance Characteristics

Drum Clutch Torque: The performance of the drum clutch, *Fig.* 5, is shown in *Fig.* 2. This torque-ampere curve resembles the B-H curve closely and there is no evidence that the torque varies according to the square law through any part of the characteristic. Clutch characteristics are not materially affected by the speed between the two members.

At low speeds and natural ventilation the drum clutch, *Fig.* 5, will handle about 30 watts with a 40

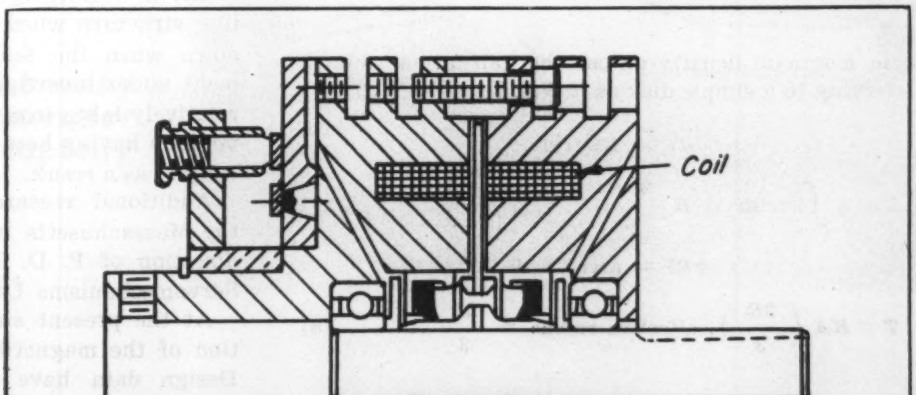


Fig. 6—Disk clutch provides a high ratio of torque to inertia. The disk should be used as the driven member

C temperature rise, would be rated 42 lb-in. on that basis, and would deliver one hp at 1800 rpm with an ample margin of safety. With the test figures as a starting point, a formula for the performance of clutches of different sizes can be derived as follows:

$$\text{Torque} = K\left(\frac{2\pi b^2}{4}\right)r$$

(constant × 2 paths × core area × radius)

Constant K may be determined from the characteristics of a specific clutch:

$$T = K\left[\frac{2\pi}{4}(1.290)^2\right]0.960 = 2.52K = 42 \text{ lb-in.}$$

$$K = \frac{42}{2.52} = 16.7 \text{ lb/sq in. core area} \quad \ldots\ldots\ldots\ldots (6)$$

The clutch in question was made of SAE 1112 steel and was tested with a magnetic fluid composed of Carbonyl E iron powder, light spindle oil, and a wetting agent.

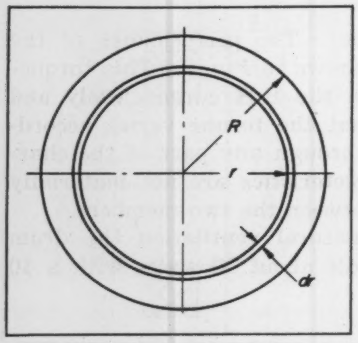


Fig. 7 — Simple disk clutch diagram

Disk Clutch Torque: Performance of a disk clutch should parallel that of a drum clutch if a uniform magnetic density across the gap is maintained. Referring to a simple disk as in *Fig.* 7,

$$dT = K2\pi r^2 dr$$

$$T = K\int_0^R 2\pi r^2 dr = K\frac{2\pi R^3}{3} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (7)$$

$$\pi R^2 = \text{area} = A$$

$$T = KA\left(\frac{2R}{3}\right), \text{ effective radius} = \frac{2R}{3} \quad \ldots\ldots\ldots (8)$$

For a given diameter, the drum type clutch is about 50 per cent more effective than the disk type. This is shown in Equation 7 but a comparison of *Figs.* 5 and 6 will show that the design itself imposes restrictions on the torque obtainable from a disk clutch. However, the disk clutch places four paths in series easier than a drum clutch design, and this is an advantage. The performance curve of the disk clutch, *Fig.* 6, is shown in *Fig.* 3. This shows that there is practically no difference between breakaway torque and slipping torque, also that torque varies as the ampere turns and follows the B-H type curve. Performance of the disk clutch can be calculated as follows:

$$T = 2K\frac{2\pi}{3}\left[\frac{(1.75)^3 - 1^3}{8}\right] +$$

$$2K\frac{2\pi}{3}\left(\frac{(2.625)^3 - (2.25)^3}{8}\right) = 5.8K$$

Substituting $K = 16.7$ from Equation 6,

$$T = 5.8(16.7) = 96 \text{ lb-in.}$$

This value is well within the heat-dissipating capacity of the clutch. However, this disk clutch is designed for purposes that might include servo work and the mechanical parts are light in order to reduce inertia. The clutch is rated at 75 lb-in. for coupled service, the rating being based on the mechanical strength of the shaft and bearings.

Clutch Heating: Clutch heating must be considered when the clutch is applied as an adjustable-speed device. In this respect the magnetic fluid clutch is no different from any other slip device. Heat dissipating capacity will vary from one watt per sq in. at low speeds and natural ventilation to 4 watts per sq in. at high speeds with forced ventilation. To the heat lost in slip, coil losses must be added to obtain the total losses.

Development of this unique clutch is being pushed by a large number of manufacturers, but much of this work is being kept secret at the present time. Jacob Rabinow, the inventor of the clutch, is carrying on additional work at the National Bureau of Standards and has shown some remarkable results. Some of the work done in Mr. Rabinow's department has been concerned with the problem of holding the magnetic particles suspended in the fluid over periods of inactivity. Much has been accomplished by the addition of wetting agents. Some fluids take on a jelly-like structure when at rest, this structure breaking down when the fluid is stirred. Another development under investigation at the bureau is the use of relatively large iron particles, particles as large as 40 microns having been tested in clutches with increased torques as a result.

Additional research work is being conducted at the Massachusetts Institute of Technology under the direction of P. D. Tilton and A. J. Parziale of the Servomechanisms Laboratory.

At the present stage of development, standardization of the magnetic fluid clutch is hardly practical. Design data have accumulated, and electrical designs of magnetic fluid clutches can be made as accurately as other electrical devices, so that a clutch becomes no more a problem than a motor or generator.

Mechanical problems have been partially worked out but there are a number of points that need perfecting. The magnetic fluid is difficult to seal from the bearings. Clutches at high temperatures build up internal pressure which might be enough to destroy a seal or cause oil leakage through other parts of the clutch. At high speeds, centrifugal separation of the magnetic fluid may cause binding of the clutch or may cause failure of the gripping power.

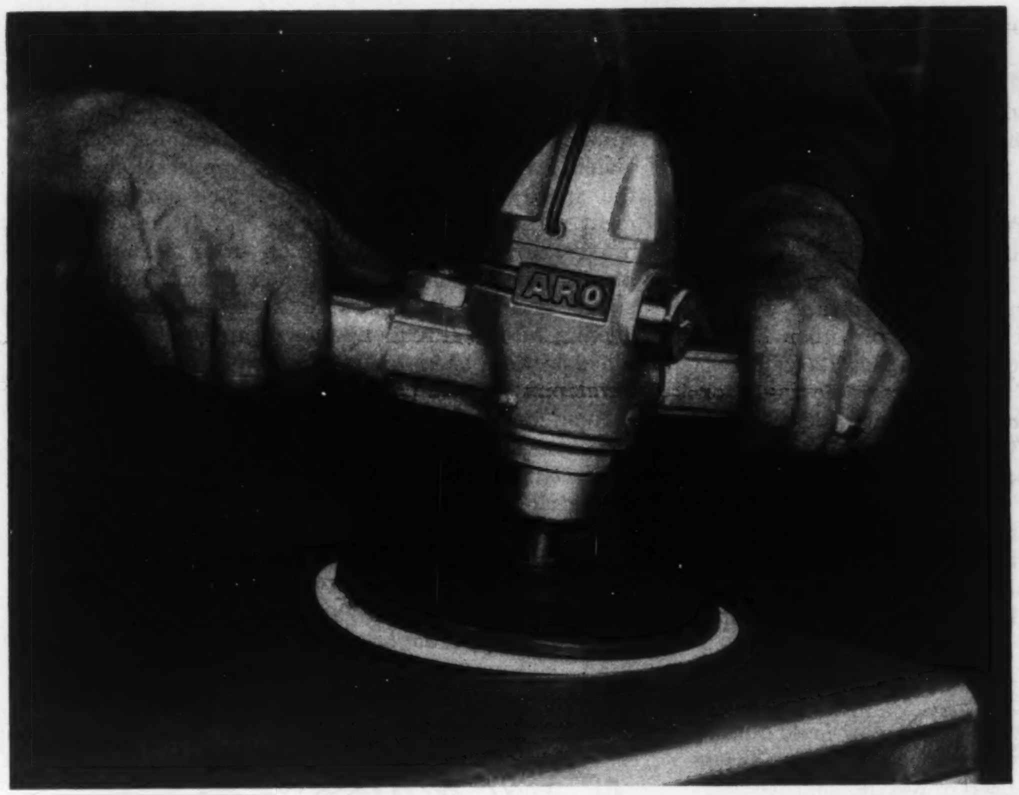
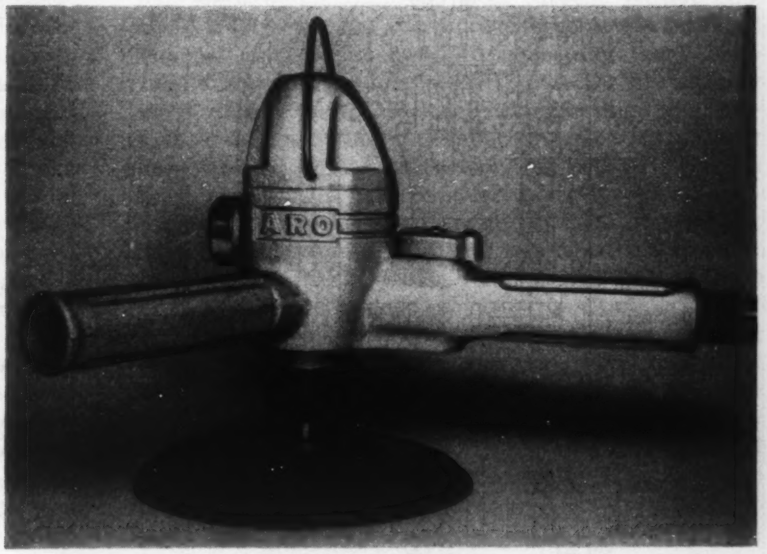


Fig. 1—Left — Portable pneumatic sander in operation, showing convenience of 120-degree spacing of handgrips. Weight of machine gives correct pressure on the sanding disk

Fig. 2—Below—View of sander from operator's side. Throttle is on right-hand grip, exhaust outlet is visible above left-hand grip



Pneumatic Sander

. . . employs magnesium housing and alloy steel working parts, for light weight and high capacity

By C. N. Douglass
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IN attempting to meet stringent design objectives proper selection of materials plays a major role. This is strikingly demonstrated in the design of the portable pneumatic sander illustrated in *Fig.* 1. As with any portable machine, compactness and light weight must go hand-in-hand with maximum power and effectiveness. Choice of magnesium for the housing, and a readily available alloy steel possessing the necessary properties for the working parts that have to "stand the gaff", made possible a design which more than satisfies the foregoing requirements.

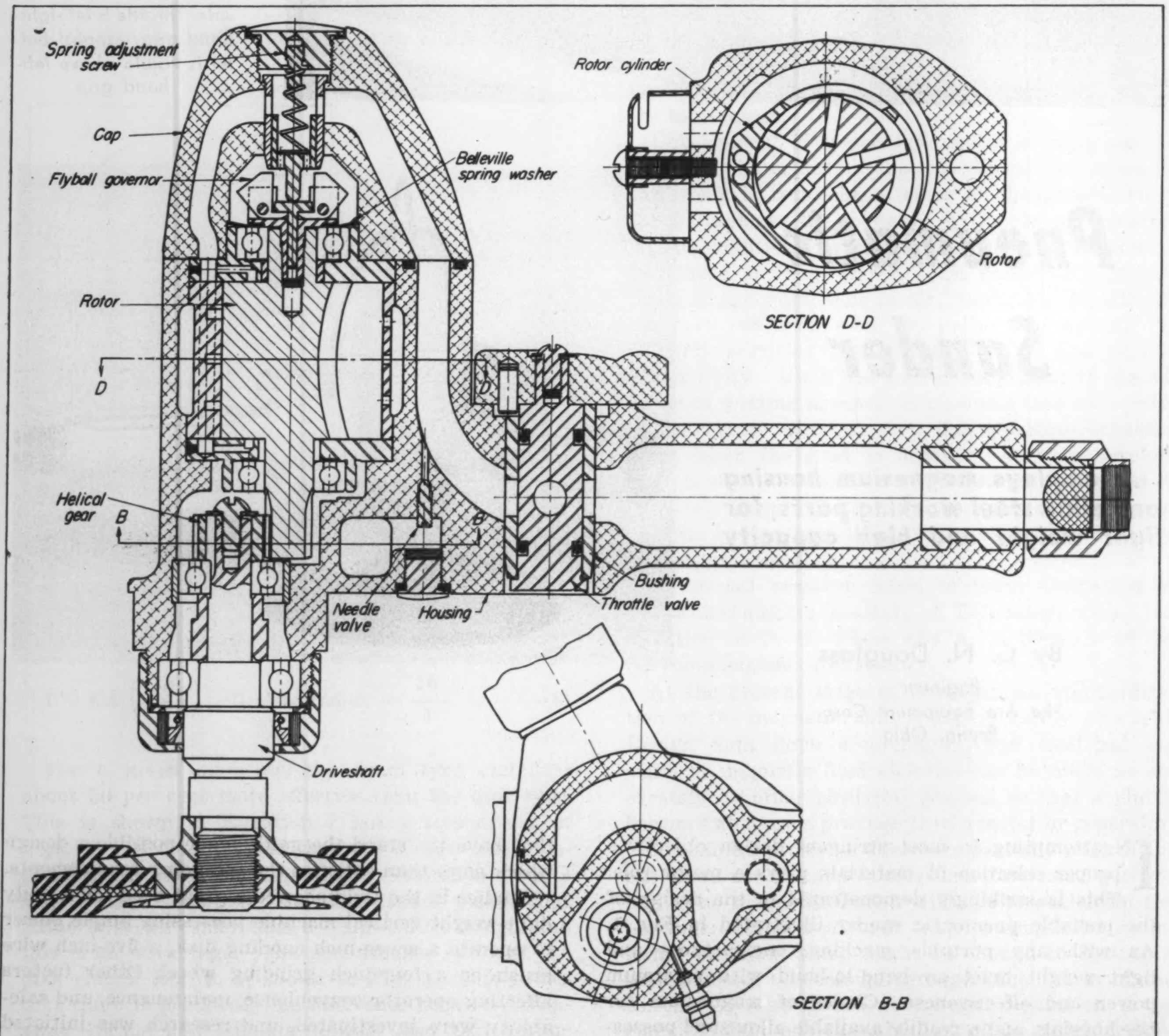
Studies in the field showed a great need for a truly light-weight vertical machine possessing ample power to operate a seven-inch sanding disk, a five-inch wire brush or a four-inch grinding wheel. Other factors affecting operator convenience, maintenance, and saleability were investigated, and research was initiated to determine the correct speed of revolution and pressure on the disk for minimum rate of disk wear. As the design progressed the all-important question of cost was kept constantly in view, a cardinal principle being to employ wherever possible standard parts which could be purchased, or components which were also used on other products manufactured by the company.

Front and back views, *Figs.* 1 and 2, and the cross-sectional drawing, *Fig.* 3, illustrate the main features of the design as finally developed for production. Measuring 8½ inches in height, the machine weighs exactly 5 pounds without the disk or other equipment. The two handles are spaced apart 120 degrees, which was found to be the most comfortable angle for the operator, *Fig.* 1. Handle grips are identical as to size and shape. An adjustable-position throttle is arranged for convenient operation on the right-hand handle. Slow opening of the throttle prevents the working parts from coming up to speed too suddenly and producing objectionable reaction or "kick" on the operator. Throttle valve and valve bushing are stainless steel (Carpenter No. 5, a 12 per cent chromium, type 416) with O-ring seals, *Fig.* 3.

Tests having established that 5000 rpm spindle speed resulted in maximum disk life, a simple spring-loaded flyball governor is incorporated in the upper housing of the machine to maintain this speed. Provision for adjustment of spring compression enables the speed to be set accurately. The spring adjustment screw, shown in detail in *Fig.* 4, is slotted and pried apart 0.005 to 0.010-inch prior to heat treatment which consists of oil quenching and tempering to hardness 44 to 48 Rockwell C. To provide adequate locking of the thread by this simple means required the selection of a tough-tempering steel capable of developing a yield point in excess of 200,000 psi. The chrome-nickel alloy steel which is also used for the principal moving parts, as discussed later, was found to meet these requirements.

Contributing largely to the light weight of the machine is the adoption of sand-cast magnesium alloys

Fig. 3—Cross-section through sander shows principal working parts and design of housing and air passages



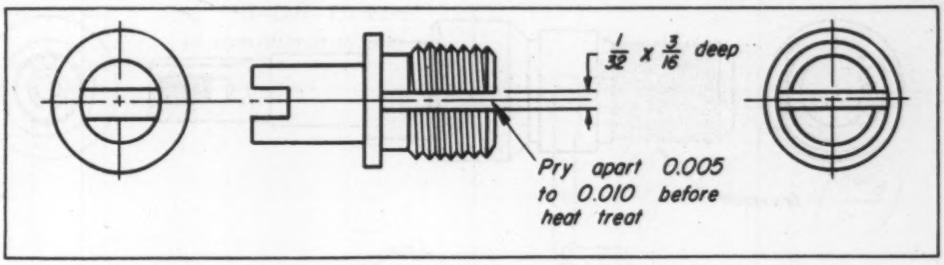


Fig. 4—Detail of spring adjustment screw which locks in place by virtue of pressure on threads as they are compressed by the tapped hole

for the one-piece housing, cap and auxiliary handle. As *Figs.* 1, 2 and 3 show, the main housing supports the motor and reduction gears and includes the air inlet passage forming the right-hand handle. A second casting, or cap, on top of the machine, houses the governor and serves to hold the rotor assembly in place. The two are held together by four machine screws removal of which permits almost complete disassembly of the machine. An O-ring seals the joint against air leakage. In designing the cored passages in these two castings particular efforts were directed toward providing ample area and smooth contours to insure unrestricted air flow, *Fig.* 3. As a result the motor develops in excess of one horsepower at rated speed and 90 psi air pressure. A third casting forms the left-hand handle.

Styling Follows Functional Lines

Exterior contours of the three castings were designed by the company's stylist, Mr. R. Robillard, and follow the principles of "eye-appeal" adopted for other products of the company. Although the machines and tools produced by Aro are somewhat diversified in function, they nevertheless exhibit a distinctive family resemblance. The desired visual effect was achieved without adding any superfluous metal, and it will be observed from *Fig.* 3 that the contours follow closely the functional lines of the working parts. Finish is a baked blue-gray "hammer" finish.

Heart of the machine is the air motor with associated helical gears and driveshaft. These three parts, details of which are illustrated in *Figs.* 5 and 6, are subject to severe wearing conditions. They are also somewhat complex in shape. A material therefore was required which would be strong, tough, and wear resistant, fairly easy to machine, and capable of easy heat treatment, without deforming. In previous tools employing similar components a number of materials had been employed, with varying degrees of success. For all three parts in this new design a chrome-nickel alloy steel with both tough-tempering and hard-tempering characteristics was chosen. Identified by its producers, the Carpenter Steel Co., as No. 5-317, this material has the following nominal composition:

Carbon	0.50 per cent
Manganese	0.50 per cent
Silicon	0.20 per cent
Chromium	1.00 per cent
Nickel	1.75 per cent

This steel was developed in an effort to simplify the selection of alloy steels by reducing the number of compositions offered to designers.

For the rotor, *Fig.* 5, a requirement is high hardness for the helical gear teeth at the output end. Heat treatment was therefore chosen to give a hard temper, and consisted of oil quenching from 1440-1465 F followed by tempering to 300-350 F, resulting in hardness 54-57 Rockwell C. Heating was performed in controlled-atmosphere furnaces to prevent decarburization and oxidation. As will be observed from *Fig.* 5, the part requires a variety of machining operations including turning, milling, hobbing, drilling, and tapping. Cutting speeds with Carpenter No. 5-317 can be approximately 60 per cent of those used for SAE 1020 steel.

Peculiar shape of the rotor demanded considerable toughness and also gave rise to some difficulties with distortion when using other materials, which were obviated with No. 5-317. Its substitution for SAE 4640 in rotors of this type having an integral pinion permitted a hardness increase of at least ten points without danger of fracture. Extended fatigue tests have shown a resulting three to five-fold im-

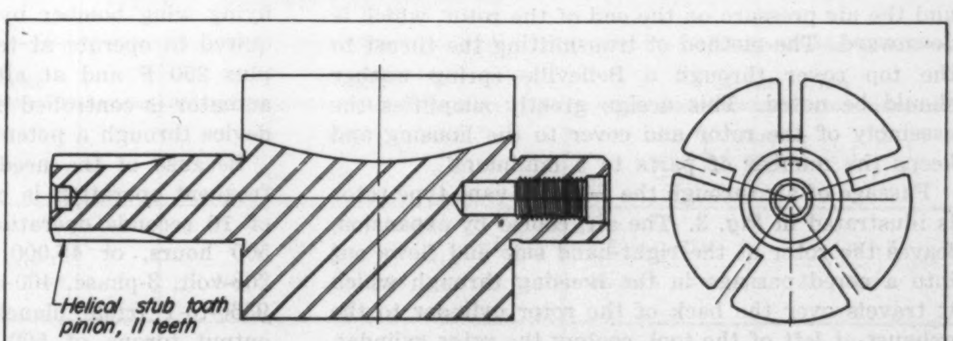


Fig. 5 — Rotor for air motor, which presents heat-treating problems because of irregular sections. Selection of proper oil-hardening steel obviated distortion or failure in service

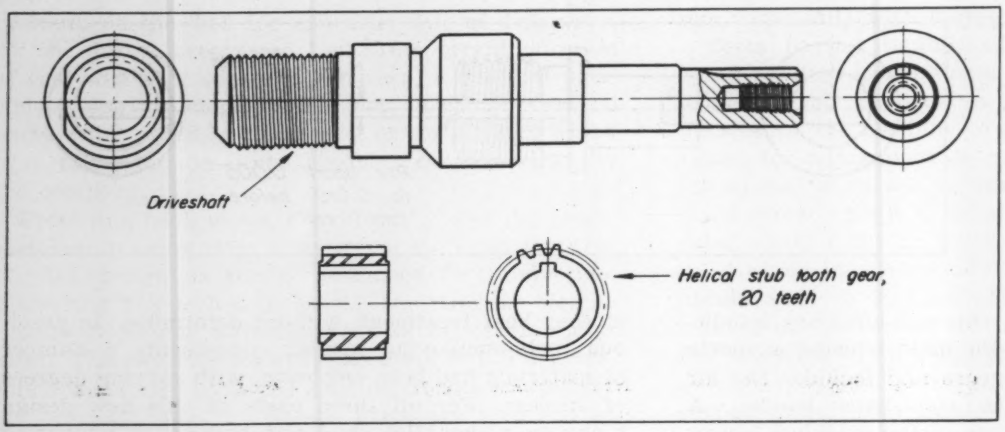


Fig. 6—Driveshaft and output gear which are oil-quenched alloy steel; shaft is tempered for toughness and hardness, and gear for a somewhat higher degree of hardness

provement in life of the pinion.

Similar hard tempering was employed for the 20-tooth helical gear, *Fig.* 6, to insure maximum life for the gear teeth. The gears provide a speed reduction of 1.82 to one from the rotor to the driveshaft and are 30/40 normal diametral pitch with a 20-degree 3-minute helix angle and 13/32-inch face width.

Driveshaft or spindle, *Fig.* 6, requires somewhat greater toughness along with relatively high hardness. Severe stress conditions exist at the keyway, while the screw threads at the output end must resist the wear due to possible frequent attachment and removal of the disks. The shaft itself transmits the full thrust and torque, and supports the weight of the tool. It also must withstand the operator's handling of pads and wheels, as well as possible shock from dropping. After oil quenching from 1425-1450 F the part is tempered to 500-550 F giving a hardness of 48-52 Rockwell C. Black oxide finish is applied to both rotor and driveshaft.

Belleville Washer Simplifies Design

As the cross-sectional view, *Fig.* 3, shows, the rotor and driveshaft are each supported on two ball bearings. Lower bearing on the driveshaft carries the thrust difference between the upward force on the pad and the downward axial thrust from the helical gear. Removal of the threaded cover permits removal of the driveshaft from the housing. Upper bearing on the rotor carries the thrust difference between the axial thrust of the helical gear, which is upward, and the air pressure on the end of the rotor, which is downward. The method of transmitting the thrust to the top cover through a Belleville spring washer should be noted. This design greatly simplifies the assembly of the rotor and cover to the housing and keeps the number of parts to a minimum.

Passage of air through the 5-bladed vane-type rotor is illustrated in *Fig.* 3. The air, cooled by expansion, leaves the rotor at the right-hand side and flows out into a cored passage in the housing through which it travels over the back of the rotor cylinder to the exhaust at left of the tool, cooling the rotor cylinder. The vanes are held against the sleeve by air pressure admitted to the slots through drilled passages at each end. The slotted exhaust baffle, visible in *Fig.* 1, can be rotated so as to deflect the exhaust air in any desired direction—either toward or away from the operator. It is of interest to note that the baffle is a sheet metal cup drawn in dies which were made for an entirely different part. Use of available dies effected a substantial saving in cost.

Lubricant for the gears and driveshaft bearing is introduced through a grease fitting of the Aro type, visible at the left center of *Fig.* 1. Oil for lubricating the rotor is applied, usually once a day, by removing the plug which appears in *Fig.* 1 just below the exhaust baffle. As *Fig.* 3 shows, this leads to a cored chamber where the oil is stored. The threaded needle valve which connects this chamber with the main air inlet can be adjusted to give the correct amount of lubricant. The principle of operation is this: When the throttle is opened air pressure backs up through the small opening at the needle valve into the oil chamber. When the tool is momentarily turned off, as happens continually in operation, the pressure in the oil chamber forces a small quantity of oil into the air passage. As soon as the throttle is opened again this oil is picked up by the incoming air and carried in the form of a mist to the moving parts comprising the rotor assembly.

Bomber Pressure Control

AN electrical pressurization control actuator made by the Hoover Electric Co., Los Angeles, is used to regulate internal pressure in the Northrup flying wing bomber by bleeding off excess air. Required to operate at temperatures from minus 76 to plus 250 F and at altitudes up to 50,000 feet, the actuator is controlled by a direct pressure measuring device through a potentiometer on the actuator.

Because of the need for precise pressure control, frequent operation is called for, dictating a life test of 10 seconds operation and 30 seconds of rest for 500 hours, or 45,000 operating cycles. A 1/6-hp, 208-volt, 3-phase, 400-cycle motor driving through a 9360-to-1 triple planetary gear reduction gives an output torque of 500 inch-pounds at 1 rpm. The output shaft is stopped in less than ½-degree of rotation by a 28-volt d-c magnetic clutch and brake.

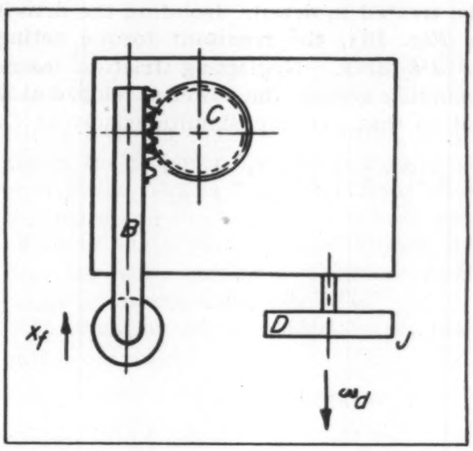
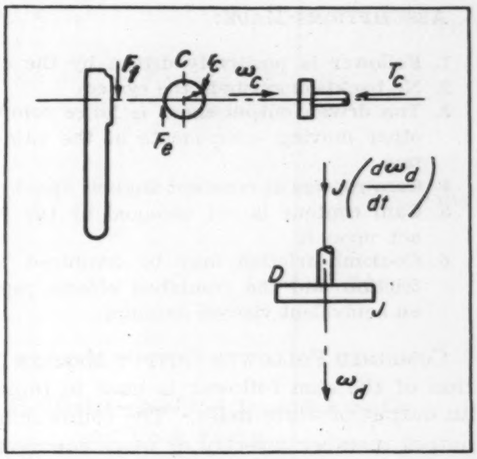


Fig. 15—Left—Elements of cam driven system

Fig. 16 — Right — Cam driven system of Fig. 15 with parts isolated to simplify analysis of forces acting on various components



Key Factors in Cam Design and Application

By John A. Hrones
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Part II—Cam Contour Types

IN practically all cam applications the lift is fixed by the output requirements of the system. Additional factors enter into the determination of the nature of the follower motion x_f. In systems where the cam operates valves controlling the flow of fluids it is often desirable to get the value to its wide-open position as soon as possible, maintain that position and close rapidly. In indexing applications a premium is placed on utilizing as small a fraction as possible of the cam cycle. In all applications it is necessary to select a follower motion, x_f, which will produce the minimum possible stresses and smoothest operation.

The discussion of the simple system shown in *Fig.* 11 (Part I) indicates that many of the limitations of systems using a cam exist because of the inherent forces and stresses which are produced. A judicial selection of cam contour will result in lower force levels and more satisfactory operation.

A brief summary of the necessary analysis follows.[1]

TABLE I—Follower Characteristics

Type of Cam	Displacement	Velocity	Acceleration
Constant acceleration	$\frac{x_f}{L} = 2\left(\frac{\theta}{\theta_o}\right)^2$	$\frac{1}{L\omega_p}\left(\frac{dx_f}{dt}\right) = \frac{4\theta}{\theta_o^2}$	$\frac{1}{L\omega_p^2}\left(\frac{d^2x_f}{dt^2}\right) = \left(\frac{2}{\theta_o}\right)^2$
Harmonic displacement	$\frac{x_f}{L} = \frac{1}{2}\left[1 - \cos\frac{\pi\theta}{\theta_o}\right]$	$\frac{1}{L\omega_p}\left(\frac{dx_f}{dt}\right) = \frac{\pi}{2\theta_o}\sin\frac{\pi\theta}{\theta_o}$	$\frac{1}{L\omega_p^2}\left(\frac{d^2x_f}{dt^2}\right) = \frac{1}{2}\left(\frac{\pi}{\theta_o}\right)^2\cos\frac{\pi\theta}{\theta_o}$
Cycloidal	$\frac{x_f}{L} = \frac{1}{\pi}\left[\frac{\pi\theta}{\theta_o} - \frac{1}{2}\sin\frac{2\pi\theta}{\theta_o}\right]$	$\frac{1}{L\omega_p}\left(\frac{dx_f}{dt}\right) = \frac{1}{\theta_o}\left[1 - \cos\frac{2\pi\theta}{\theta_o}\right]$	$\frac{1}{L\omega_p^2} = \frac{2\pi}{\theta_o^2}\sin\frac{2\pi\theta}{\theta_o}$

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[1] References are listed at end of article.

Assumptions Made:

1. Follower is positively driven by the cam
2. No backlash exists in the system
3. The driven output mass is large compared to the other moving components of the cam-driven system
4. Cam rotates at constant angular speed
5. Cam contour is not changed by the forces which act upon it
6. Coulomb friction may be combined with viscous friction and the combined effects represented by an equivalent viscous damping.

Combined Follower-Output Member System: Motion of the cam follower is used to impart motion to an output of finite mass. The follower may drive the output member directly or more commonly through a system of gears and levers. The follower is coupled to the output member by a relatively stiff system. A possible arrangement of such a system is shown in *Fig.* 15. This system is chosen as one of many to illustrate the discussion. It will be observed that it in no way limits the applicability of the method to other systems. Generally the mass of the output member is very large relative to the follower and the components of the coupling system. Thus no appreciable error results by assuming the mass of all other elements of the system to be zero.

Equivalent System Stiffness: The equivalent system stiffness, *K*, is defined as the force required to deflect the follower one inch if the output member is rigidly held, the force being applied at the center of the roller and along the line of motion of the follower.

Equivalent Mass of Driven Member: *M* is the equivalent mass of the driven member referred to the displacement, x. Its value in any given system is readily found by tracing the inertia force or torque back through the coupling system to the reciprocating motion, x_f.

To illustrate the procedure, the system shown in *Fig.* 15 will be treated in detail. Isolating the driven member (see *Fig.* 16), the resultant torque acting upon it is $J(d^2\theta_f/dt^2)$. Neglecting friction losses and mass of coupling system, the power developed at *D* must be equal to that existing simultaneously at *C:*

$$T_c \frac{d\theta_c}{dt} = \left[J \frac{d^2\theta_d}{dt^2} \right] \frac{d\theta_d}{dt}$$

but

$$\frac{d\theta_d}{dt} = n \frac{d\theta_c}{dt}$$

therefore

$$T_c = n^2 J \left(\frac{d^2\theta_c}{dt^2} \right)$$

also

$$F_c = \left(\frac{n}{r_c} \right)^2 J \frac{d^2x}{dt^2}$$

therefore

$$M = \left(\frac{n}{r_c} \right)^2 J$$

The system shown in *Fig.* 17 is therefore dynamically equivalent to the actual system providing *M* and *K* bear the values indicated in the foregoing.

Force transmitted to the follower is the sum of the force developed in the equivalent spring, *K*, and the dashpot force. To determine the maximum cam load it is therefore necessary to find this force as a function of the time for a given follower displacement.

Forces on the Cam Follower: The solid lines in *Fig.* 18 show the equivalent mass *M* and the follower at rest at the time $t = 0$. At some time, *t*, the position is as indicated by the dotted outlines.

A summation of the forces acting on mass *M* yields the following result:

$$M \frac{d^2x}{dt^2} + b \left(\frac{dx}{dt} - \frac{dx_f}{dt} \right) + c \frac{dx}{dt} + K (x - x_f) = 0$$

Fig. 17—Equivalent system in which force transmitted to follower is sum of force developed in equivalent spring, K, and the dashpot force

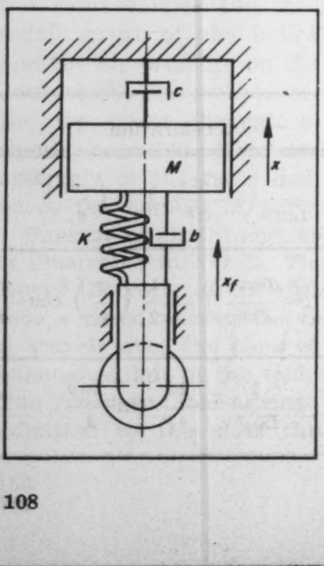


Fig. 18—Equivalent mass, M, and the follower (solid lines) at rest when time, t, is equal to zero

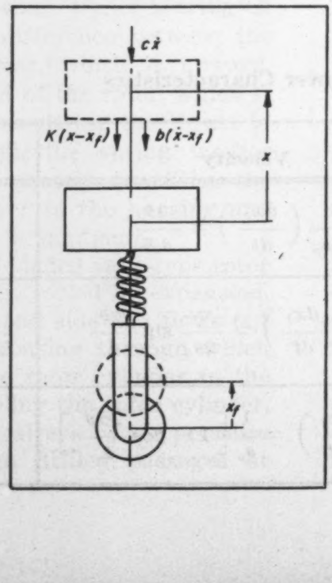
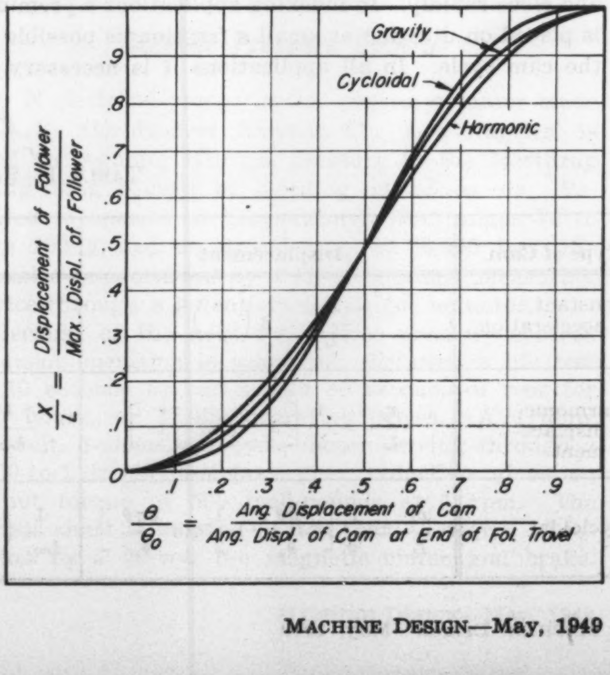


Fig. 19—Displacement characteristics of cam follower



or

$$M\frac{d^2x}{dt^2} + (b + c)\frac{dx}{dt} + Kx = b\frac{dx_f}{dt} + Kx_f \quad (16)$$

where b is the equivalent viscous damping factor between the follower and the output mass and c is the equivalent viscous damping factor between the output mass and the frame. It is here assumed that the effect of static and viscous friction may be lumped together with sufficient accuracy and expressed in terms of viscous damping.

If Equation 16 is divided by M, the following result is obtained

$$\frac{d^2x}{dt^2} + 2\left(\zeta + \zeta_c\right)\omega_n\frac{dx}{dt} + \omega_n{}^2x = 2\zeta\,\omega_n\frac{dx_f}{dt} + \omega_n{}^2x_f \quad (17)$$

where $\omega_n = (K/M)^{1/2}$ = undamped natural frequency of output mass, $\zeta = b/2\sqrt{KM}$ = damping ratio (follower), and $\zeta_c = c/2\sqrt{KM}$ = damping ratio (frame).

The component of force acting on the cam follower in the x direction is

$$F = K(x - x_f) + b\left(\frac{dx}{dt} - \frac{dx_f}{dt}\right) \quad (18)$$

To evaluate the forces given by Equation 18 either the follower motion, x_f, or the motion of the driven mass, x, must be known. From the viewpoint of output requirements it appears logical to establish the required motion of the driven mass and determined follower motion and therefore cam contour from Equation 17. Dudley[2] has discussed this approach applied to the design of valve gear. It is more common practice to prescribe the follower motion, x_f. In some cases this permits the use of simple contours which can be generated. Secondly, the calculations required are, in general, simpler. Because of the increased performance which can be realized at high speeds by proper output motion specification, there appears to be adequate incentive for wider use of the first approach.

Relatively few types of cam contours are widely used. Some of these are discussed in the following.

1. Constant Acceleration or Gravity Cam: A cam which produces a follower motion

$$\frac{x_f}{L} = 2\left(\frac{\theta}{\theta_o}\right)^2 \quad (19)$$

where

$$0 < \theta < \frac{\theta_o}{2}$$

$$\frac{x_f}{L} = 1 - 2\left[1 - \frac{\theta}{\theta_o}\right]^2 \quad (19a)$$

where

$$\frac{\theta_o}{2} < \theta < \theta_o$$

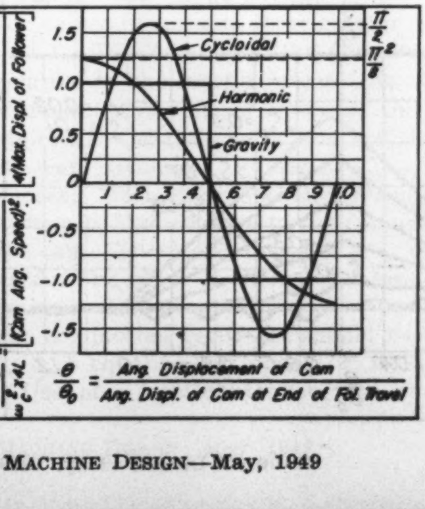


Fig. 20 — Acceleration characteristics of cam follower

Table II—Relationship of Damping Ratio and Peak Force

Type	ζ_o	$\frac{F}{Ma_g}$
Constant acceleration	0	3
	0.1	6.5
	0.3	16.5
	0.5	26.5
	0.7	36.5
	0.9	45.5
Harmonic	0	2.47*
	0.05	4.32
	0.1	11.1
	0.2	16.7
	0.3	24.7
	0.5	41.4
	0.7	58.1
Cycloidal	0	1.72**
	0.05	6.28
	0.1	11.0
	0.2	21.2
	0.3	31.8
	0.5	52.5
	0.7	72.9

* Obtained by multiplying values on *Fig.* 21*e* by 1.236.
** Obtained by multiplying values on *Fig.* 21*d* by 1.57.

2. Harmonic Displacement Cam: A cam which produces a follower motion

$$\frac{x_f}{L} = \frac{1}{2}\left[1 - \cos\frac{\pi\theta}{\theta o}\right] \quad (20)$$

3. Cycloidal Cam: A cam which produces a follower motion

$$\frac{x_f}{L} = \frac{1}{\pi}\left[\frac{\pi\theta}{\theta_o} - \frac{1}{2}\sin\frac{2\pi\theta}{\theta_o}\right] \quad (21)$$

Velocity and acceleration characteristics of the follower for the foregoing displacement functions are shown in Table I. Displacement, velocity, and acceleration curves of the follower are plotted in *Figs.* 19 and 20.

The follower of the constant acceleration cam has the lowest peak acceleration but starts off with a finite acceleration which remains constant until half-lift position is reached, where it suddenly changes to the same negative value. A sudden change back to zero acceleration occurs at full-lift position.

Acceleration of the harmonic displacement cam follower starts off with its peak value and changes continuously, passing through zero at half lift. At full lift, the acceleration undergoes a sudden change from its peak negative value to zero.

Acceleration of the cycloidal cam changes continually from zero at the start of lift to zero at full lift, exhibiting no sudden changes. Its peak value is higher than either of the peaks of the previously discussed cam contours.

Cam Forces for Specific Cam Contour: If the foregoing follower motions are inserted in Equations 17 and 18, the solution of the resulting differential equations may readily be obtained. The results follow:

For constant acceleration cam

$$\frac{dx_f}{dt} = a_g t$$

where

$$a_g = 4L\left(\frac{\omega_p}{\theta_o}\right)^2$$

For harmonic displacement cam

$$\frac{dx_f}{dt} = \frac{a_h \theta_o}{\pi \omega_p}$$

where

$$a_h = \frac{L}{2}\left(\frac{\pi \omega_p}{\theta_o}\right)^2$$

For cycloidal cam

$$\frac{dx_f}{dt} = \frac{\theta_o a_c}{2\pi \omega_p}\left[1 - \cos\frac{2\pi\theta}{\theta_o}\right]$$

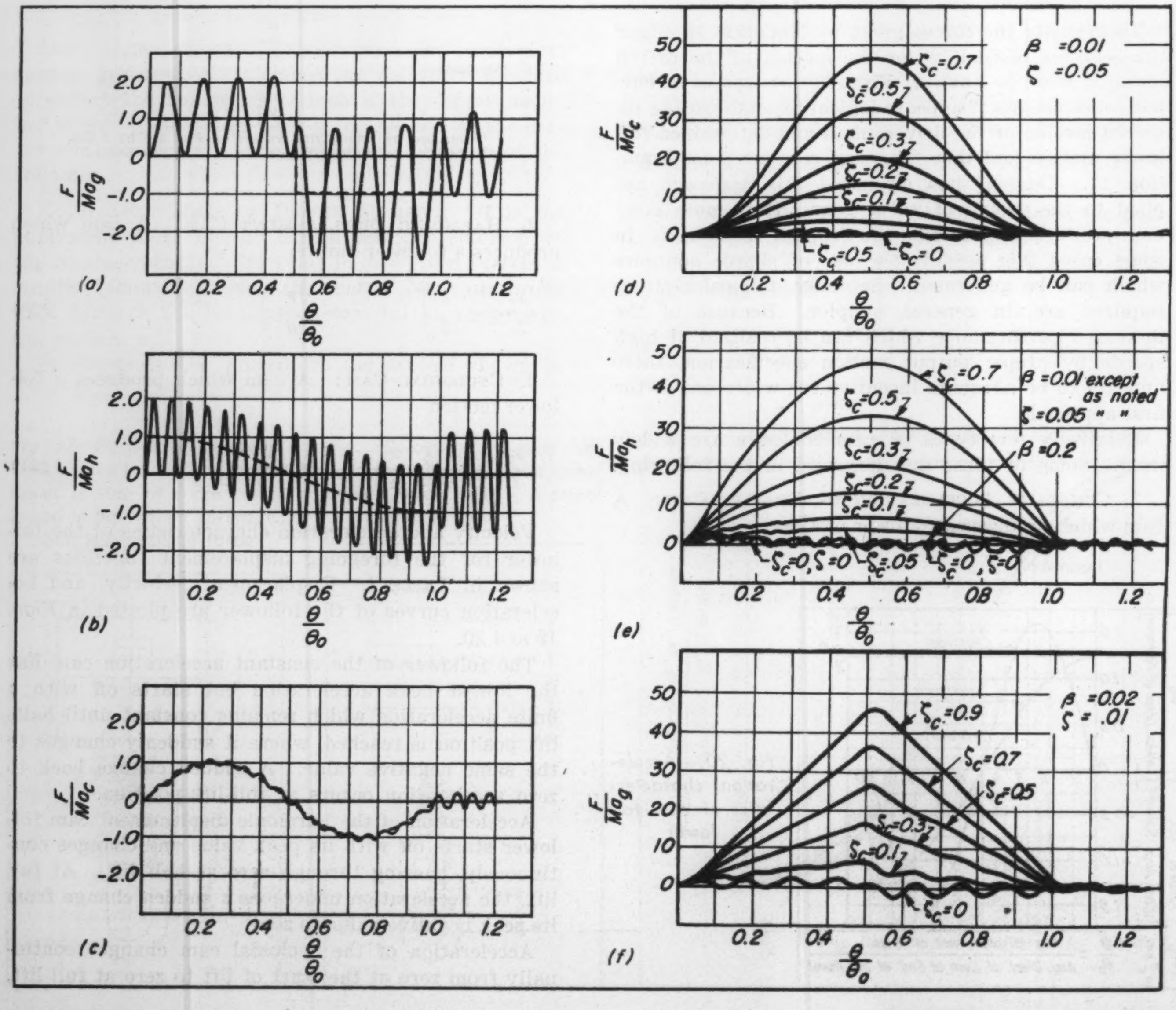
where

$$a_c = 2\pi L\left(\frac{\omega_p}{\theta_o}\right)^2$$

Forces resulting from the use of these three contours are plotted in curves *a* through *f* of *Fig.* 21.

Ratio of force on the cam along the follower centerline to the product of the equivalent output mass and maximum acceleration of the follower is plotted against the ratio of cam displacement to the cam displacement required to produce full lift. This product, *Ma,* is the maximum value *F* would reach if the mo-

Fig. 21—Below—Ratio of axial cam force to the product of driven mass and maximum follower acceleration, for various follower motions. (a)—Constant acceleration follower motion; (b)—Harmonic follower displacement; (c)—Cycloidal follower displacement; (d)—Cycloidal follower displacement; (e)—Harmonic follower displacement; (f)—Constant acceleration follower motion



tion of the equivalent mass were the same as the cam follower. This ratio is, therefore, a measure of the cam force amplification resulting from the spring-dashpot coupling between the cam follower and the output. In each case the follower motion plotted occurs between two dwell periods.

Discussion of Results: With no damping present, the force, F, oscillates at the natural frequency, ω_n. For the constant acceleration cam, peak value of the ratio F/Ma_g during the first half of the follower motion is equal to two. Immediately after midposition, where the follower acceleration suddenly changes from a positive value to a negative one of equal magnitude, a peak force ratio of three is reached. (see *Fig.* 21, curve *a*).

With a harmonic follower motion, an oscillation of the same frequency occurs with a peak value of two (*Fig.* 21, curve *b*). With the cycloidal follower motion an oscillation of the same frequency but of much smaller amplitude occurs. Peak value of the force ratio is 1.06 (*Fig.* 21, curve *c*).

As the damping ratio ζ_c (damping between output mass and the frame) is increased, the transient oscillation decreases rapidly but the peak force increases rapidly as shown in Table II. For damping ratios, ζ_c, greater than 0.1 with cycloidal follower motion, no force reversal occurs, *Fig.* 21*d*. For the harmonic and constant acceleration cams a very slight force reversal takes place near the end of the travel for values of ζ_c equal to or greater than 0.1, *Figs.* 21*e* and *f*. This is because the damping forces are large relative to the inertia forces. As the damping ratio increases, the general shape of the force-time curve approaches the shape of the velocity-time curves of the cam follower. Values of ω_p/ω_n were arbitrarily chosen. Normally the natural frequency of the driven system is high relative to the frequency of rotation of the cam. Therefore, ratios of $\beta = 0.01$ and 0.02 were used. The effect of changing values of β in the range of low values of β is shown in *Fig.* 21*e*. In comparing the plotted results it should be remembered that a_c/a_g is equal to 1.57 and a_h/a_g is equal to 1.236.

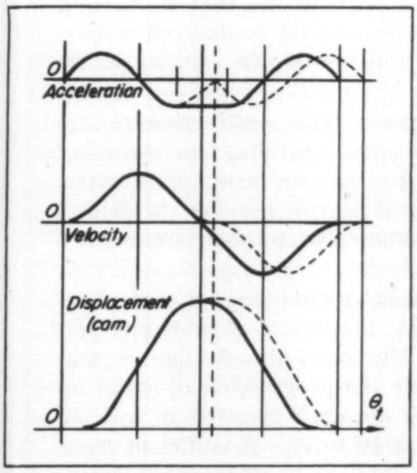


Fig. 22—Characteristics of parabolic contours (full lines) and cycloidal contours (dotted lines)

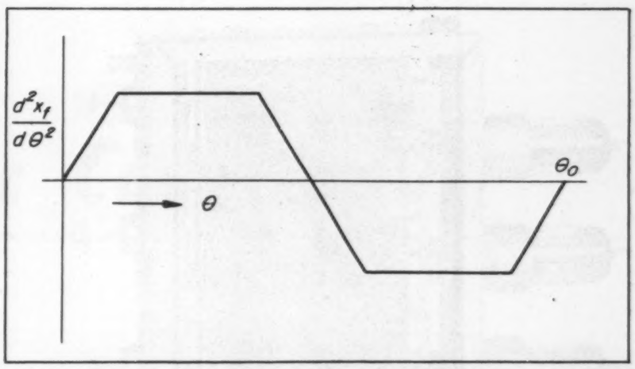


Fig. 23—Combined cubic and parabolic follower motion

Use of a cam contour of the cycloidal type produces the following desirable results at low damping ratios:

1. A lower peak force along the axis of the cam follower.
2. Amplitude of the transient force variation taking place at the natural frequency of the driven system is much smaller than that produced by the other two cam contours. This should result in longer life of the cam surface and other elements of the machine. It should yield quieter as well as smoother machine performance. Operation at increased speeds should be possible.

Maximum value of the pressure angle is greater for the cycloidal cam than for the other contours discussed if all other dimensions are held fixed and only the contour changed. However, at low values of damping ratio the maximum pressure angle occurs at nearly zero ratio with a cycloidal cam. In the constant acceleration cam the maximum pressure angle occurs at nearly maximum values of the force ratio. In order to obtain the results here predicted in actual operation, the cam contour must be machined to close tolerances. An error of a few ten-thousandths of an inch in the initial or final stages of the rise will seriously affect the system performance. This is also true in the case of gear action. In recent years a tremendous improvement in gear performance has resulted from the recognition of need for holding tooth contours within very close limits. A great improvement in cam operation will result when the importance of close tolerances is fully recognized and production methods are used which permit attainment of the desired accuracy.

It is well to point out that the cycloidal follower displacement does not necessarily represent an optimum solution to the cam problem. However, it does offer an opportunity for tremendous improvement in dynamic performance over that obtained by either the constant acceleration or harmonic displacement type cams. A dynamic analysis of the results produced by any other cam contour can be carried out by the methods outlined in Ref. 1.

It is important to avoid sudden changes in follower acceleration. For cams without dwell a harmonic follower displacement will meet this requirement. For cams with dwell periods before and after the rise, a cycloidal follower displacement avoids sudden accel-

(*Concluded on Page* 178)

Controlling Ma

By Earl B. Hitchcock
Engineer
Potter Instrument Co. Inc.
Flushing, N. Y.

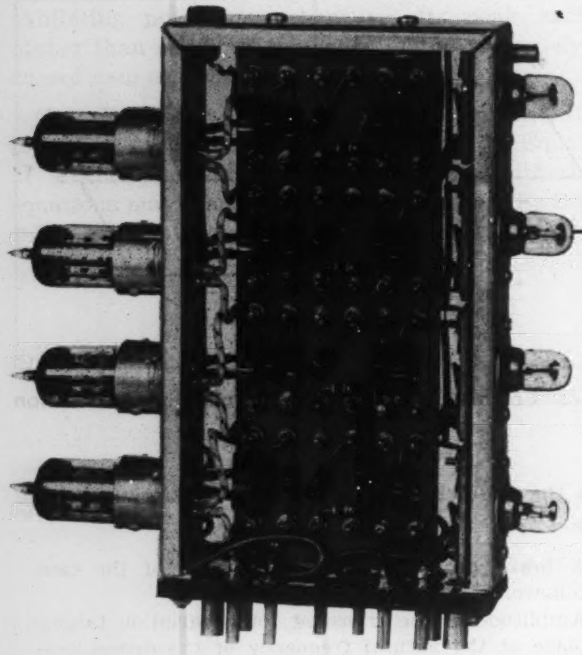


Fig. 1—Above—Typical plug-in counter decade. These units are assembled in tandem to increase capacity of counter

Fig. 2—Below—Diagram of count progression from 0 to 10. Shaded circles represent neon lamps on indicating count

Pulse No.	Stage 1	Stage 2	Stage 4	Stage 8	Count
0	○	○	○	○	=0
1	●	○	○	○	=1
2	○	●	○	○	=2
3	●	●	○	○	2+1 =3
4	○	○	●	○	=4
5	●	○	●	○	4+1 =5
6	○	●	●	○	4+2 =6
7	●	●	●	○	4+2+1 =7
8	○	○	○	●	=8
9	●	○	○	●	8+1 =9
10	○	○	○	○	Reset to 0

COMPLEXITY and sensitivity of an automatic control system may seriously limit its usefulness on high-speed production lines. An electronic device, however, which is known as a decade counter, is simple enough in design to overcome these disadvantages and yet is so versatile that it is being used in varied applications such as automatic control of zipper-making machinery or extremely accurate projectile velocity measurements.

This electronic counter offers three basic advantages to the machine designer. First, there is no practical limit on counting speed, rates as high as 1,600,000 per second being obtainable. Second, the count is accurate, since it is not possible to skip a count electronically. Third, maintenance due to wear on moving parts is eliminated.

METHOD OF OPERATION: The basic decade, *Fig.* 1, is a plug-in assembly consisting of four tubes, four neon glow lamps and associated resistors and capacitors. The neon glow lamps are designated as 1, 2, 4, and 8, and register the progression of count up to 9 as shown in *Fig.* 2. A second decade connected in tandem would be used to indicate the count of 10 to 99. A sufficient number of decades may be connected in tandem to register the maximum number required.

Rather than attempt to discuss the electronic circuit in detail, it will be simpler to illustrate the principle of the decade counter by means of a mechanical analogy, *Fig.* 3. This system corre-

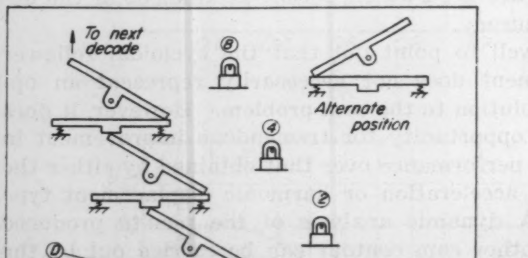


Fig. 3—Left—Mechanical analogy, showing principle of operation of electronic counter

DUAL PREDETERMINED ELECTRONIC COUNTER

Fig. 4 — Right — Typical predetermined electronic counter. Decades shown in Fig. 1 are plugged into the chassis. This counter will predetermine two separate numbers in succession desired

hines with Electronic Counters

sponds to the 4-tube decade, but instead of feeding electrical pulses into the circuit to be counted, the mechanical system counts mechanical impulses imparted to a spring-mounted beam *A* at the point shown in the lower right-hand corner of the sketch.

Initially, the system will be in equilibrium with each of the pivoted beams in position as shown. When the first pulse to be counted is received, beam *B* will swing around its pivot and come to rest with its left end resting on beam *A* as shown in the alternate position. In this position, the system is so arranged that indicating lamp *C* is energized thus giving a visual indication of count 1. The second pulse received will return beam *B* to its original position, at the same time transmitting a mechanical impulse to beam *D* which corresponds to *A* in the first stage of the system. This pulse will initiate action in the second stage of the system, lighting the indicating lamp to indicate count 2. Each additional pair of pulses applied to the first stage will similarly cause one pulse to be transmitted to the second stage. Furthermore, four pulses applied to the first stage will cause two pulses to be transmitted to the second stage and one pulse to the third. Thus we have achieved a binary counting system operating in the sequence 1, 2, 4, 8.

Lamps Indicate Count

If the indicating lamps in each stage are labelled according to this succession, the number of input pulses may be read at any time by adding together the numbers indicated by the lighted lamps. *Fig.* 2 shows how the count progresses from 0 to 10.

To make the system a decade counter, it is necessary to return each stage to its initial condition at the count of 10, as well as transmit one pulse to the next decade which will count tens rather than units. Although too complex to show by mechanical analogy, this is easily accomplished by a feedback system in the electronic counter circuit. Thus, the electronic decade counter, *Fig.* 4, triggered by electrical impulses and using a modified Eccles-Jordan circuit for each counting stage, counts instantly, with absolute accuracy and without mechanical inertia at rates up to 1,600,000 per second, this speed being adequate for any normal operation.

METHOD OF PREDETERMINING: One of the features that vastly increase the versatility of the electronic counter is its ability to initiate one or more control functions after a predetermined number of counts has been registered. Indeed, this versatility is so wide that two, three or more such numbers may be preset and the control functions initiated in order after each predetermined count has taken place. It is important to note that in recycling, the counter resets instantly, so that there is no reset time delay to slow up operation of the control.

To predetermine the desired count, a simple method is used. A set of dial switches presets the complement of the wanted number electronically into the circuit so that, when the counter has reached a full count, an output pulse is obtained from the final stage. Such a counter has a total capacity of 1000 after which it generates an output pulse and resets to zero. To predetermine a count within this range, for example 800, the complement number with respect to 1000 is 200. Electronically then, 200 will be preset

Fig. 5—Example of machine tool application of electronic counter. The counter is used to control the lathe tool feed

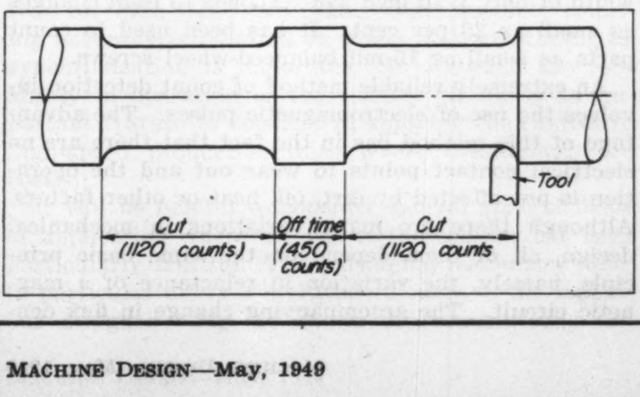
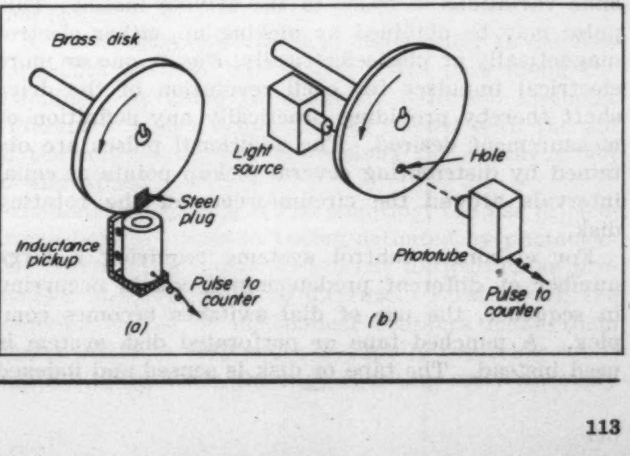


Fig. 6—Pickup methods: At (a) the electromagnetic pulse is generated as the steel slug rotates through the magnetic field of the pickup coil. At (b) the photoelectric pulse is picked up as the hole in the disk rotates past the light



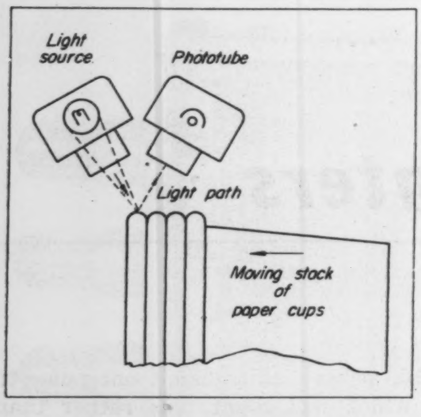


Fig. 7—Photoelectric method of counting paper cups. As the cups move through the light beam, light is reflected from the rolled edge of each cup back to the phototube

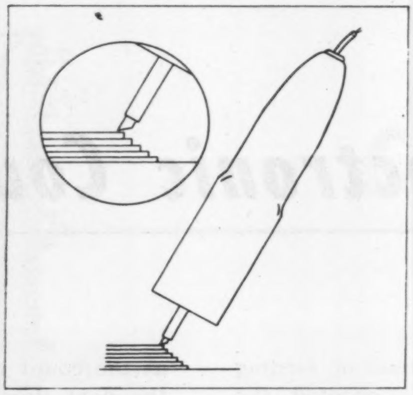


Fig. 8—Stylus used for counting paper sheets electronically. As the stylus moves down the stepped edge, a count is generated at each step, quickly totalling sheets in a stack

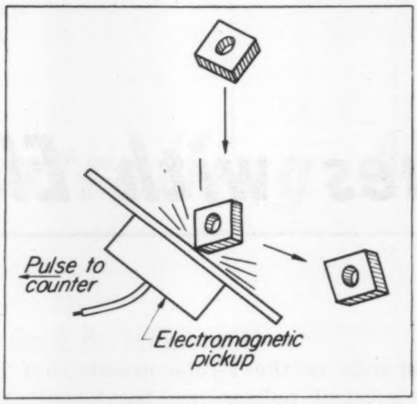


Fig. 9—Impact method of count detection. A pulse is generated magnetically whenever an object strikes the inclined plate. Objects may be of any desired shape

into the counter, so that when the counter is set in operation and 800 counts are added, it will have reached its capacity and generate the required control impulse. To recycle, the complement is automatically preset again and the same sequence occurs.

As previously stated, more than one number may be predetermined by using additional sets of dial switches, one set for each number. In this case, an electronic switch is used to select the additional predetermined numbers in order after the first predetermined count has been reached and the output circuit provides separate and distinct controls at the end of each of the selected counts.

This type of circuit is of value in setting up a program of control functions to occur in precisely determined sequence. As an example, consider a machining operation performed on a lathe where the tool moves the length of the work but only a certain length of the stock is removed, *Fig.* 5. By deriving counts as a function of shaft rotations, it is possible to use an electronic counter to automatically control the lathe tool cross feed to make the desired cut. It is only necessary to determine the cut length in terms of shaft revolutions and make the number of shaft revolutions the predetermined count. Of course, the length of cut is easily varied by varying the predetermined count. A count pulse which is absolutely synchronized to the rotating speed of the work is important in order to keep the pulses in step with possible variations in speed of the driving motor. This pulse may be obtained by picking up, either electromagnetically or photoelectrically, *Fig.* 6, one or more electrical impulses for each revolution of the drive shaft thereby providing practically any definition of measurement desired. The additional pulses are obtained by distributing several pickup points at equal intervals around the circumference of the rotating disk.

For elaborate control systems requiring a large number of different predetermined counts occurring in sequence, the use of dial switches becomes complex. A punched tape or perforated disk system is used instead. The tape or disk is sensed and indexed after each count, presetting the next number each time. With this system any number of predetermined counts may be selected.

COUNT DETECTION METHODS: Basically there are only two methods of count detection that need be considered in this article. They are the photoelectric and electromagnetic detectors. Although other methods exist, none of them are as simple and as widely applicable. Under the photoelectric detection method there are two ways of obtaining the required signal. Basically the photoelectric method consists of a light source and a phototube to receive the light. When arranged so that the light beam falls directly on the cathode of the phototube the signal is obtained when the light beam is interrupted by the passage of the object to be counted.

Shown in *Fig.* 7 is an alternative photoelectric detection method. Here the phototube and light source are placed side by side and the objects to be counted reflect light back onto the phototube as they move by the light source. In this illustration a stack of paper cups is being counted by the pulse of reflected light from the rolled edge of each cup. This same method is used for counting stacked tin can ends or other materials providing a serrated surface.

Small Parts Are Counted Rapidly

A special high resolution photoelectric count detector has been developed for the rapid counting of extremely small parts. This detector has a beam width of only 1/16-inch and responds to light changes as small as 20 per cent. It has been used to count parts as small as 10-mil balanced-wheel screws.

An extremely reliable method of count detection involves the use of electromagnetic pulses. The advantage of this method lies in the fact that there are no electrical contact points to wear out and the operation is not affected by dirt, oil, heat or other factors. Although there are many variations in mechanical design, all of them depend on the same basic principle, namely, the variation in reluctance of a magnetic circuit. The accompanying change in flux den-

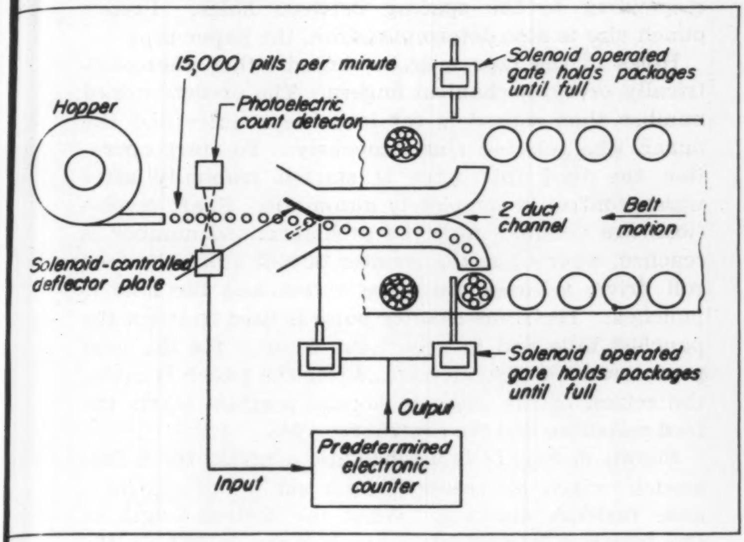

15,000 pills per minute
Solenoid operated gate holds packages until full
Hopper
Photoelectric count detector
2 duct channel
Belt motion
Solenoid-controlled deflector plate
Solenoid operated gate holds packages until full
Output
Predetermined electronic counter
Input

Fig. 10—Diagram showing operation of a pill packaging machine using predetermined electronic counter control

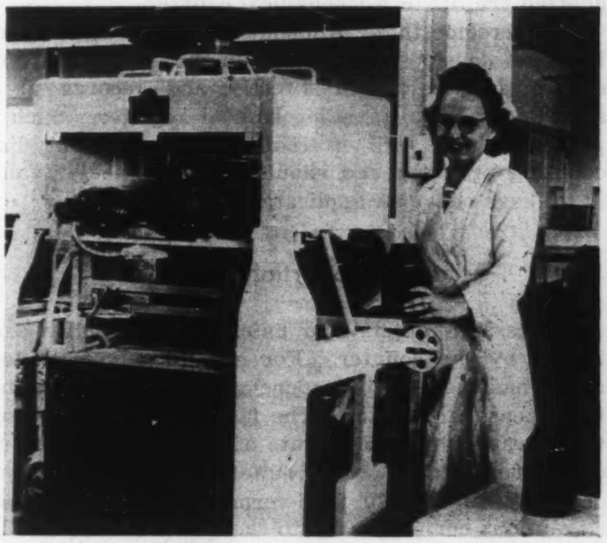


Fig. 11—Pill packaging machine in operation using the counter control diagram in Fig. 10

sity causes a corresponding change in the induced voltage of the linked electrical circuit and this pulse is counted. An example of this type of pickup has been shown in *Fig.* 6.

A widely used method of counting stacked sheets of paper has been developed using an electromagnetic pickup. The paper is riffled and stacked so that each sheet forms a step in height. A sapphire tipped stylus is then run down the steps as shown in *Fig.* 8. The movement of the stylus from step to step provides the electromagnetic impulse.

Shown in *Fig.* 9 is still another type of electromagnetic detection. The objects to be counted are dropped one at a time on an inclined plate where a pulse is generated for each impact. Since this type of detector responds to impact, the part may be of any shape or material.

Will Control Many Functions

APPLICATIONS: Although the device under discussion is called a counter, its wide applicability makes it suitable for such functions as time-interval measurement, process control, batch control and high-speed switching operations. In general it may be said that any machine or process which now requires cams, gears, patterns, chains or other systems for timing control may be advantageously controlled by a predetermined electronic counter. This is particularly true for high-speed processes, where absolute counting accuracy is required or where accurate timing or synchronization is important. In addition, the reliability in operation of the counter circuit is an important feature to consider in applying the control to high-speed production lines where breakdowns are costly.

It will be helpful to consider several general fields of application where the use of the counter has been particularly fruitful. The packaging machinery field, in particular offers a multitude of uses to the ingenious designer. *Fig.* 10 shows diagrammatically the operation of a pill batching and packaging machine, while *Fig.* 11 is a photograph of the complete machine which packages pills at the rate of 12,000 per minute and batches them in exact quantities variable from 1 to 1000. Similar applications exist for packaging nails, bottle caps, screws, buttons, etc. with equally precise control.

Totals Counts from Many Chutes

In the past it has been necessary, when counting small objects for packaging or inventory, to pass the objects by a detector one at a time. Of course, such a method seriously limits the possible counting speed. To overcome this disadvantage a system has been developed which utilizes a number of parallel feed channels and parallel detectors which are capable of resolving and totalizing simultaneous counts. Such a system makes it possible to feed at low speed and count at high rates. For example, with a simple sorting mechanism which feeds the objects in single file at the rate of 10 per second in each of 10 parallel channels, a counting rate of 100 per second or 6000 per minute is achieved. *Fig.* 12 shows a ten-channel shake table feed with steps and restrictions for feeding. The objects drop from the end of each channel through one of ten photoelectric beams. The counter itself is mounted remotely and is not illustrated in this picture.

A box folding machine uses the counter to displace each 25th or 50th box as the boxes pass along the machine. By using photoelectric detection methods, differently labeled boxes may be sorted with the aid of the counter as they move along the conveyor belt at high speed.

Industrial production line counting, the use of electromechanical counters (often actuated by photoelectric relays) has begun to present difficulties as production rates continue to increase. First of all, the inherent inertia of mechanical counters make them unresponsive to very short or rapidly recurring count pulses. In addition, the high counting rates seriously shorten the life of a mechanical counter.

To overcome these problems, an electronic counter has been developed which counts the photoelectric or electromagnetic pulses directly and records at a scaled-down rate on a mechanical register. Such a packaged unit will overcome many assembly-line counting problems and should be of particular value in package conveyor applications.

Controls Proportions in Mixing

Processing, mixing and batching are readily controlled by the counter. For example, a small flow meter has recently been developed using the counter as a measuring device. The flow meter is of the rotating vane type and its rate of rotation is picked up electromagnetically, the resultant pulses operating a decade counter. By predetermining the number of revolutions corresponding to the quantity desired, the control may be used to measure out precise equal quantities of liquid into bottles or batches. The same type of control would be of great value in blending processes since a series of counters can be arranged to measure off the quantities desired.

The counter is also well suited to the precise measurement of quantities of dry materials (grain, powder, sand, etc.) which are blended in batches and where the material is fed at constant speed. In this case, it is only necessary to set up a predetermined count, based on revolutions of the feed drive shaft, corresponding to the quantity required. Feeding will be stopped at the desired point.

Application of a counter to the control of a punch press with a multiple head for punching various sizes of holes in steel strip, is shown schematically in *Fig.* 13. The problem is to accurately control the spacing of the holes and select the proper head to obtain the desired diameter hole. The strip is fed in by a set of feed rolls which are stopped to punch each hole. All holes are in line but spacing between holes varies widely. To solve the problem, a punched tape system is used to select a predetermined count corresponding to the spacing between holes. Proper punch size is also determined from the paper tape.

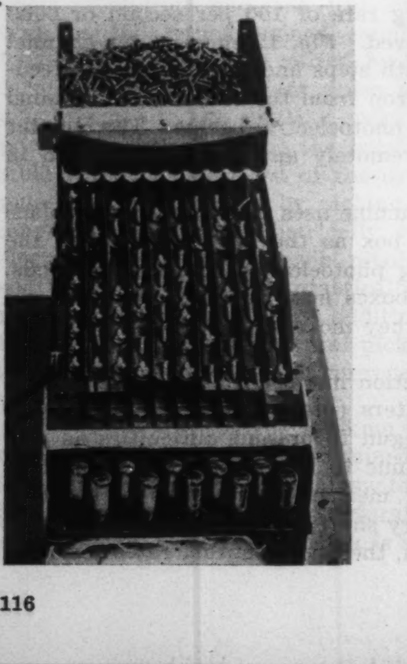


Fig. 12—Left—Multiple-channel count detector developed for accurate high-speed counting of small objects

Holes in the tape may be sensed either photoelectrically or by mechanical fingers. The predetermined number thus sensed is set into the counter and the punch size selected simultaneously. To start operation the feed roll drive is started manually after which control is completely automatic. Shaft revolutions are counted until the predetermined number is reached, whereupon the counter output stops the feed roll drive, releases the press clutch and the hole is punched. The same counter pulse is used to index the punched tape and to preset the counter for the next predetermined measurement. After the punch is made, the return of the press to normal position starts the feed roll drive and the control recycles.

Shown in *Fig.* 14 is a schematic diagram for a dual predetermined electronic counter set up to control a slide fastener machine. When the desired length of the fastener is reached, a blank space is left on the tape before the next fastener is started. The control is actuated by pulses picked up from the rotation of the machine drive shaft, so that each pulse represents the indexing of the tape by a distance of one element. The counter controls the fastener length through predetermined channel *A,* disengaging the metal feed when the selected number of teeth has been applied and keeps the feed disengaged for a number of counts predetermined by channel *B.* Both predetermined counts may, of course, be varied independently as necessary for different fastener lengths.

Stacks Exact Quantity

At present the counter is being used in steel mills for stacking tin sheets in precise quantities. *Fig.* 15 shows a schematic diagram of this application. Photoelectric detection is used and the desired stacked quantity selected by dial switches on the front panel of the counter. When the predetermined quantity is reached, a deflector mechanism operates to divert the stack into a second pile. Then a skid is placed on the first pile or the stack is staggered to receive the third pile. A dual predetermined counter may be used to slow down the line a predetermined number of counts before the final count. *Fig.* 16 is a photograph of the sheet steel counter installation.

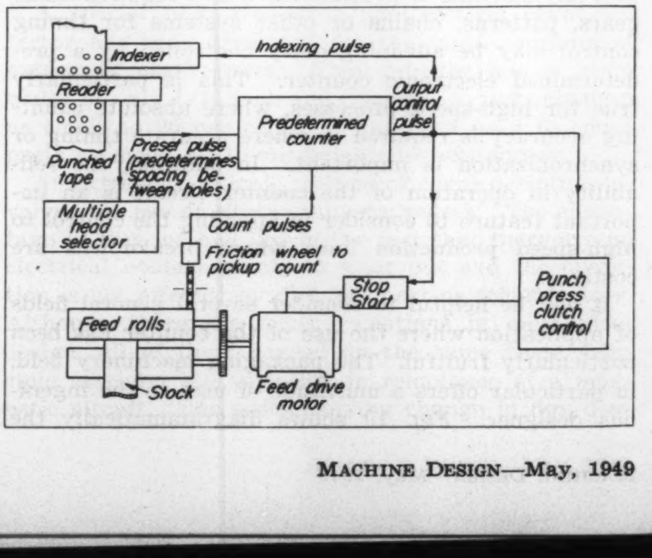


Fig. 13—Right—Diagram showing method of controlling a multiple-head punch press used for punching various sizes of holes at different spacings in steel strip material

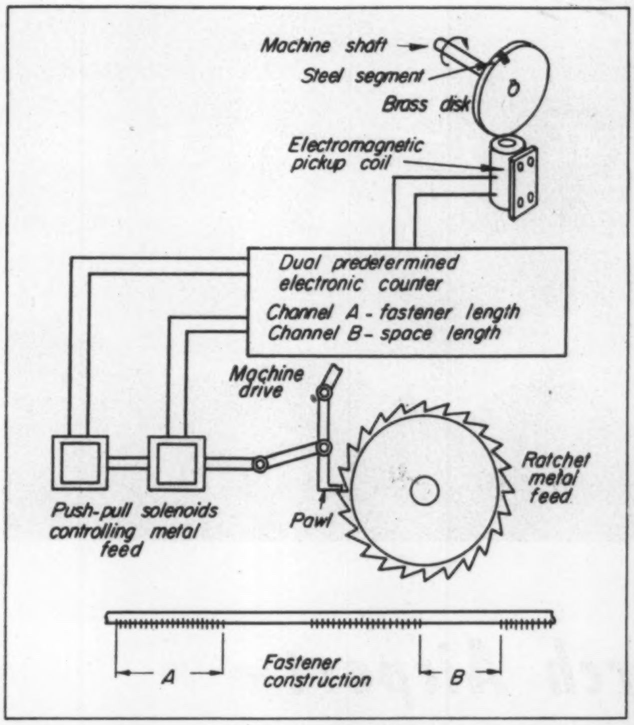

Machine shaft
Steel segment
Brass disk
Electromagnetic pickup coil
Dual predetermined electronic counter
Channel A - fastener length
Channel B - space length
Machine drive
Ratchet metal feed
Pawl
Push-pull solenoids controlling metal feed
A
Fastener construction
B

Fig. 14—Diagram showing control circuit for a slide fastener machine. Spacing on product is shown below circuit

Convenient and accurate method of measuring lineal footage uses an electromagnetic pickup, of the type shown in *Fig.* 6, attached to a friction wheel or roller operated by the movement of the material to be measured. The impulses from the pickup coil supply the input to a single-channel predetermined electronic counter. The desired length is predetermined as a function of counts and when this predetermined number is reached, a high-speed relay may be energized to operate a shear or marking device. Additional control, for example, slowing down the rate of travel before cutting, or locating defective portions of the wire, may be added by using dual or multiple predetermined counters.

As a projectile velocity measuring instrument, the counter starts to count high-frequency time base pulses when triggered by the passage of the projectile past a given point and stops counting when the projectile passes a second measuring point. The elapsed time may be read directly from the counter and if the distance between the measuring points is accurately known, the velocity is readily computed.

One of these standard counter chronograph interval timers, using a time base frequency of 1,600,000 cycles per second measures time intervals up to 1 second in steps of 0.000000625-second. A number of camera manufacturers are using this method of interval timing for calibrating and checking high-speed camera shutters. In another photographic application, the counter is used as a 1000-cycle pulse generator for a high-speed camera which continuously records transient phenomena. The 1000 cycle generator furnishes a pulse every millisecond to an argon glow lamp which records a calibration mark on the moving film.

Similar applications could be discussed at great length because counters can be applied effectively to any machine or process requiring exact measurement or control of quantity, length, time, velocity, flow, volume, frequency, or revolution. However, the examples shown and the methods outlined may be of some value to machine designers in solving similar or entirely new problems related to the control of modern machines.

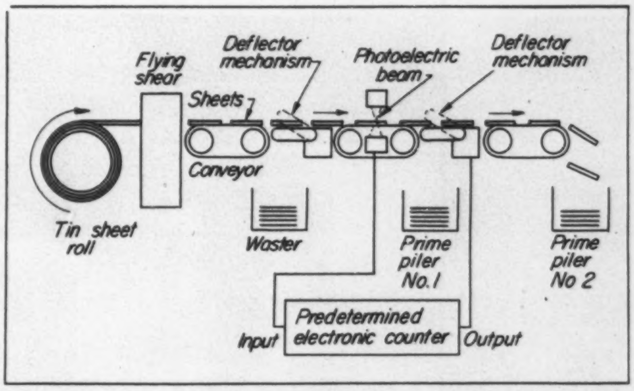
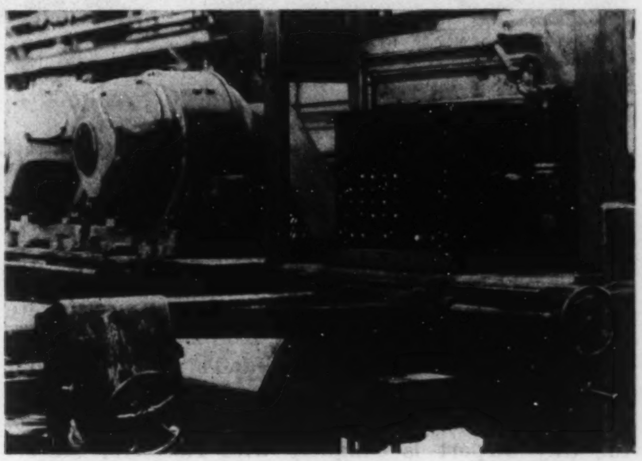

Flying shear
Deflector mechanism
Photoelectric beam
Deflector mechanism
Sheets
Conveyor
Tin sheet roll
Waster
Prime piler No.1
Prime piler No 2
Input
Predetermined electronic counter
Output

Fig. 15—Above—Diagram showing operation of electronic counter stacking predetermined quantities of steel sheets

Fig. 16—Below—Installation of electronic counter in steel mill



Correction

In the article "Selecting Flexible Couplings" (MACHINE DESIGN, April, 1949) is was stated, in error, that the Francke coupling is being made by various manufacturers. It was also stated that the Francke type is being discontinued and modified by several manufacturers.

Both statements were obviously incorrect as the Francke coupling is manufactured only by the John Waldron Corp. of New Brunswick, N. J., which holds the basic Francke patents, and no other manufacturer can either make or modify the design features of the Francke coupling.

We are informed by the John Waldron Corp., which also makes the Waldron gear type couplings, that the Francke, with its flexible pin unit construction, continues to be one of the best known and among the most widely used couplings throughout industry.

Model Research Airport

LOCATED not far from the biggest runway in the world—Patterson Field's 10,000-ft concrete giant—a miniature flying field is playing a vital role in the Air Materiel Command's extensive aviation research and development program. An integral part of AMC's model research phase of this program, the tiny airport is complete with runways, control station and all the facilities of its supersized sisters. Its purpose is to provide a test ground for the flying models which augment wind tunnel studies in obtaining important preflight data on various types of planes.

In the illustrations, a dwarf B-17 powered by four 3-hp reciprocating engines is shown on a cable-controlled test flight. The relative size of the models is shown by the baby helicopter being inspected by Adam Stolzenberger, chief of the dynamic model unit of the AMC at Wright-Patterson Air Force Base, Dayton.

The miniature airport's circular runway is 400 feet in diameter with a central pylon, actually a control line base tower, for flying the models. Outside the circle, an operator sits in a conventional pilot's seat behind full-sized controls. Strong, thin wires connect to the model's control surfaces, enabling the operator to fly it as he would a full-scale plane. Tests are filmed by a camera riding the pylon cable which follows models through all maneuvers and speeds, maintaining continual photographic contact at a constant distance.

Models are designed, built and fabricated by technicians in the model shop laboratory. They usually take about three months of painstaking effort to build, and measure from seven to 18 feet in length, and some carry a price tag of more than 25 thousand dollars.

Although the miniature airport is only a year old, already a series of tow tests have been run with two similar models to investigate stability problems involved in air-to-air refueling. A dwarf B-17 with four real engines (the miniatures fly the course under their own power) has flown around the hilltop undergoing stability tests, the results of which were later correlated with full-scale test results to yield valuable performance data.

At present, the models fly up to 200 mph with conventional reciprocating engines, but plans are underway to operate them at transonic and supersonic speeds utilizing rockets and jet engines. When this is achieved, extensive experiments will be made in the critical speed range, just at the sonic barrier, where other means of testing without risking personnel and full-scale aircraft are impossible.

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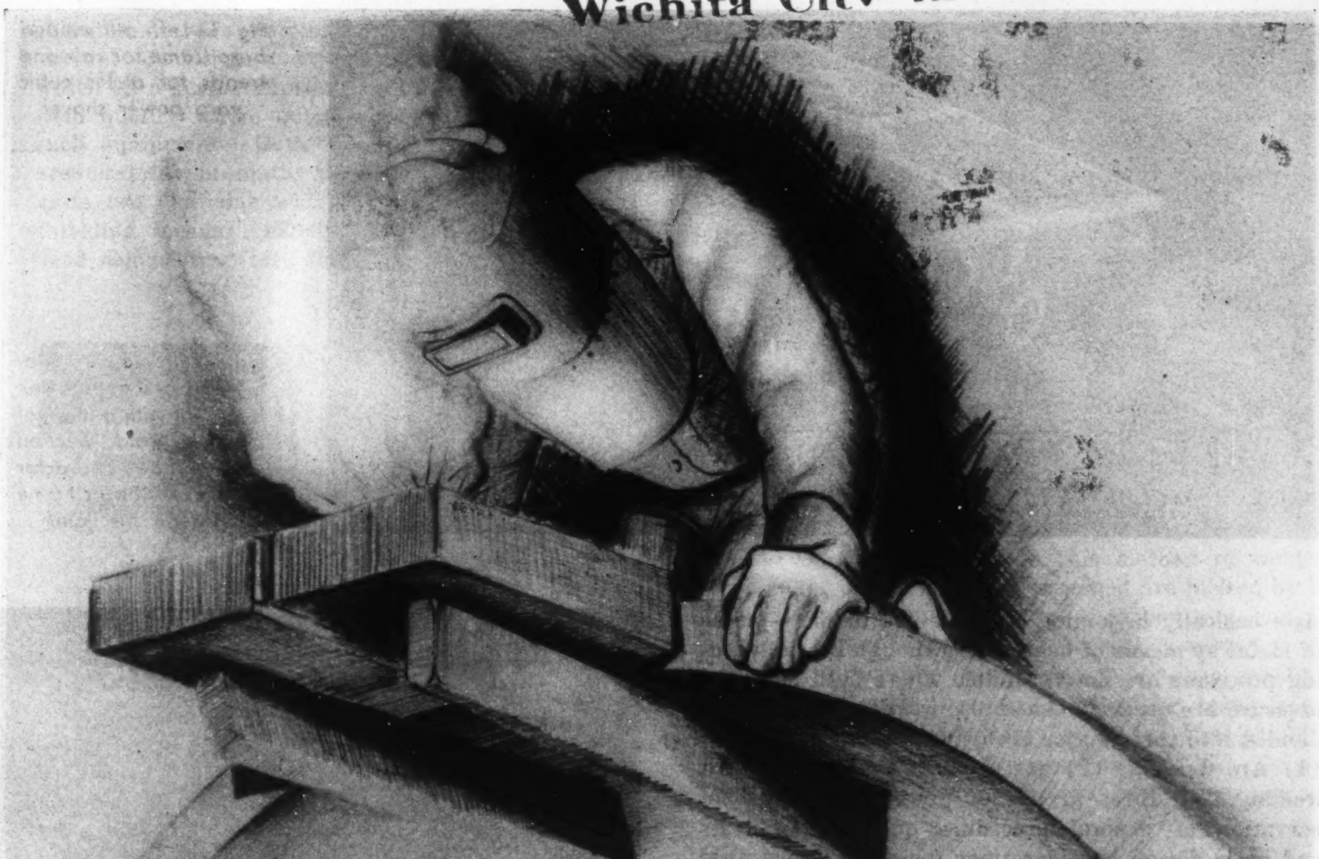


PRODUCTION PROCESSES...

Their Influence On Design

By Roger W. Bolz
Associate Editor, Machine Design

Part XLIII—Welding, General Considerations

DESIGN of machines to be fabricated by means of welding has developed apace during the past decade, *Fig.* 1. The numerous advantages offered by welding processes place these production methods among the most important where low cost and design versatility are imperative considerations. Simple and extremely useful, welding can be made most economical and satisfactory by careful observation of its fundamental characteristics and limitations.

Welding, as it is commonly practiced, con-

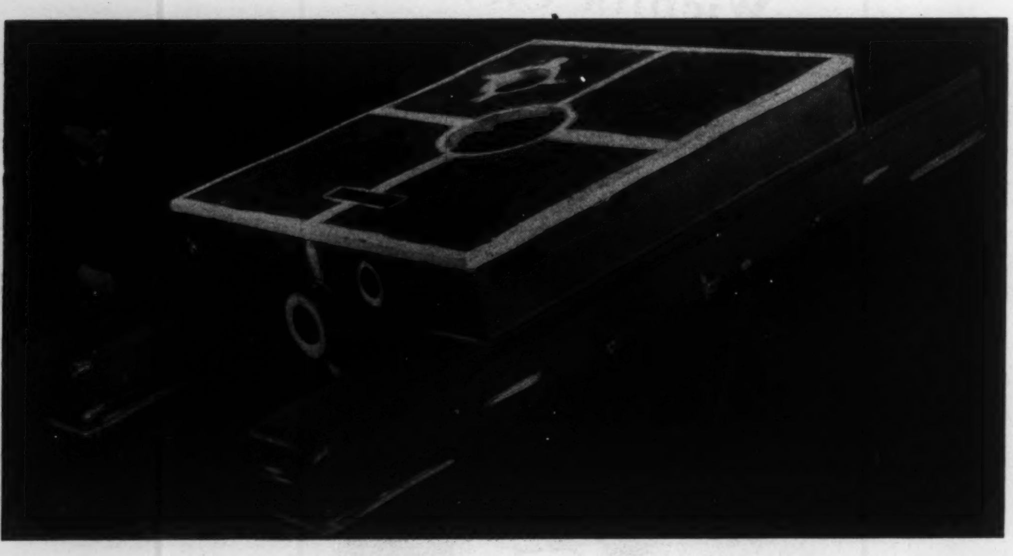
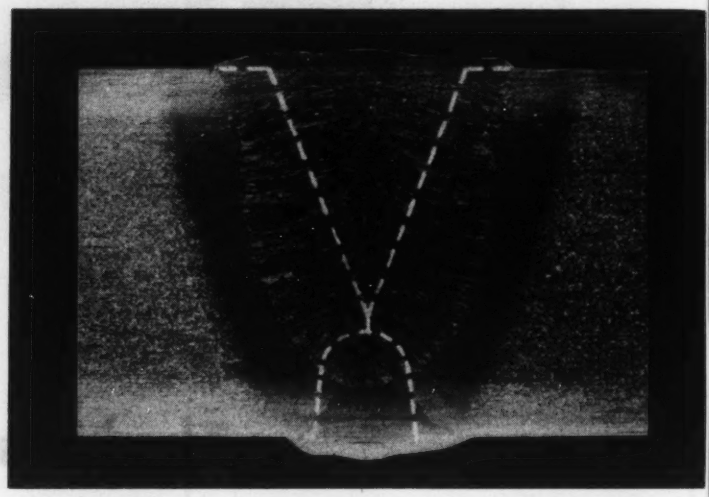


Fig. 1—Left—All welded base frame for cab and treads for a 1½ cubic yard power shovel

Fig. 2 — Below — Submerged arc double-vee butt joint with a manual backing weld. Section clearly shows character of metal structure through the joint



sists basically in joining together two or more pieces of metal by means of heat only, although special welding processes are now available where both heat and pressure are utilized. Generally, welding may be subdivided into three major groups of welding processes: (1) Arc welding; (2) gas welding; and (3) thermit welding. All three groups of processes require observation of general procedure qualification tests and basic design considerations for satisfactory weld properties, especially where highly critical designs are involved.

Arc and gas welding are the most widely utilized processes and each of these basic means of producing local fusion embraces a large group of distinct welding methods. Selection of the one welding method most suitable for a specific job depends upon many considerations such as availability of equipment, materials to be welded, design features such as accessibility, type of loading, preparation and fit-up requirements, etc. In general, therefore, the designer must be familiar with the various welding methods available and their salient characteristics in order to design eminently satisfactory weldments from structural, mechanical and cost standpoints.

Selection of Welding Method

Welding Method: An ideal weld would be one with properties identical to those of the metal being joined, *Fig.* 2. Welds made without atmospheric protection, however, result in a deposit containing absorbed nitrogen and oxygen. Such welds are brittle and should never be used for butt joints, highly stressed parts, structures subject to fatigue or impact, corrosion, or high-temperature operating conditions. Where these conditions are prevalent, selection of a suitable flux and bare or coated rod for gas welding or the most desirable shielded-arc welding process will assure satisfactory, sound welds with considerable advantage in quality, appearance, shape, speed, etc.

Proper shielding for welding protection is supplied in various ways. In covered electrode welding, shielding is accomplished by means of combustion, vaporization and melting of several ingredients of the coating. The term impregnated-tape shielding is used to designate the use of a ribbon or cord of material, similar to the electrode coating, which is fed into the weld zone to effect proper atmospheric shielding. Gas-shielded welding applies to processes wherein the weld zone is protected by a reducing or inert gas. Other methods employ a flux in the form of a paste or powder on or ahead of the weld path to wholly or partially vaporize or melt during welding and shield the weld.

Metal-Arc Welding: Heat to complete a weld by the metal-arc process is supplied by an electric arc sustained manually or automatically by proper control of the welding head. Metal for the weld—termed filler metal—is supplied when required by a metal welding electrode. In methods such as the inert-gas or the carbon-arc, the weld metal may be entirely original base metal, no filler rod being added. Use of coated rods or electrodes permits better arc control, higher currents and larger electrodes with consequent greatly increased welding speeds. Standard manual equipment with gas or flux shielding is also available and offers the advantages of these methods as well as great flexibility.

Automatic arc welding equipment permits higher current densities and consistent heat application which as a result affords the maximum in speed and weld quality where quantity justifies the expense of such equipment. Both covered and bare electrodes are used in automatic arc welding and, in addition, units are available which utilize tape, gas and flux shielding means. Either the work or the welding head can be traversed to produce the weld, commercial units which produce other than straight or circular beads being largely special. Such units are generally termed shape welders, *Fig.* 3, and are only economical where quantities are sufficiently large to justify an entirely special machine.

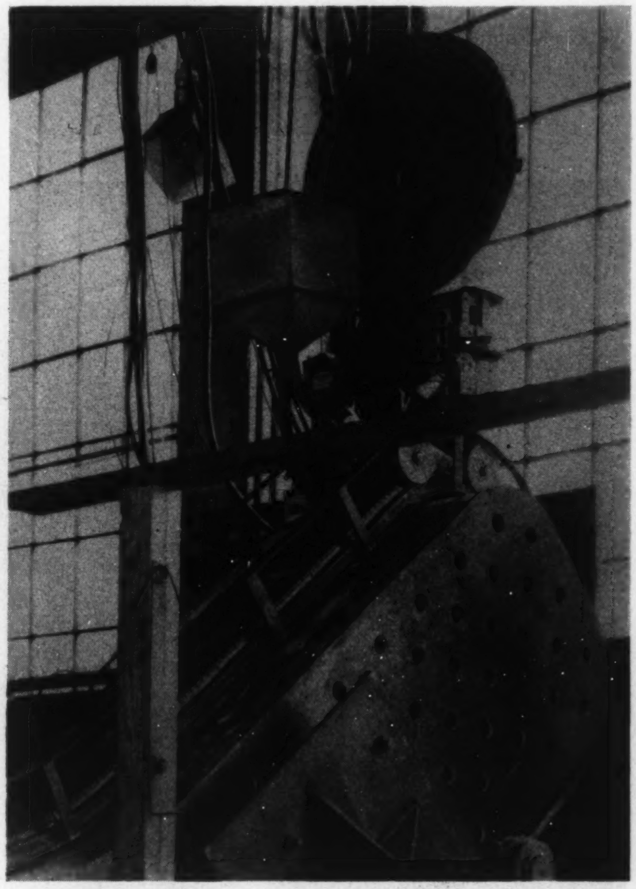


Fig. 3—Above — An ingenious control is used on this shape welder for Scotch type marine boilers, the carriage traveling along the joint which is always positioned to maintain a horizontal weld area

All types of welds can be made by manual metal-arc welding, the only requirement being that the joints are readily accessible to the welder, *Fig.* 4. All types of groove and fillet welds can be made by automatic equipment but where shielding such as powdered flux is used the welding position must remain flat. With this method, commonly referred to as submerged-arc welding, all types of metals from light-gage sheet to heavy plate can be handled and often in one pass where several would be necessary by other methods. Submerged-arc welding provides the fastest rate of deposition of any similarly applicable process.

Carbon-Arc Welding: In this method of welding, the edges of the metal to be joined are melted by the electric arc formed between a carbon rod and the work. When required, filler metal is added to the joint. Carbon-arc welding may be done manually or automatically, the widest application being in machine or automatic welding. Tape or flux shielding can be used for protecting the molten metal. In general, the method is limited to down-hand and flat positions.

Gas Welding Versatile

Gas Welding: One of the oldest methods of welding, gas welding, employs an oxyacetylene, hydrogen, natural, or manufactured gas flame to create the fusion. On other than thin sections, filler metal is fed into the prepared joint to complete the penetration. An advantage in gas welding is its versatility. Complete control by the operator of the rate of cooling as well as the rate of melting affords a degree of control over distortion and internal strains not always possible with arc welding of heavy parts. The slower heating with gas welding, however, usually

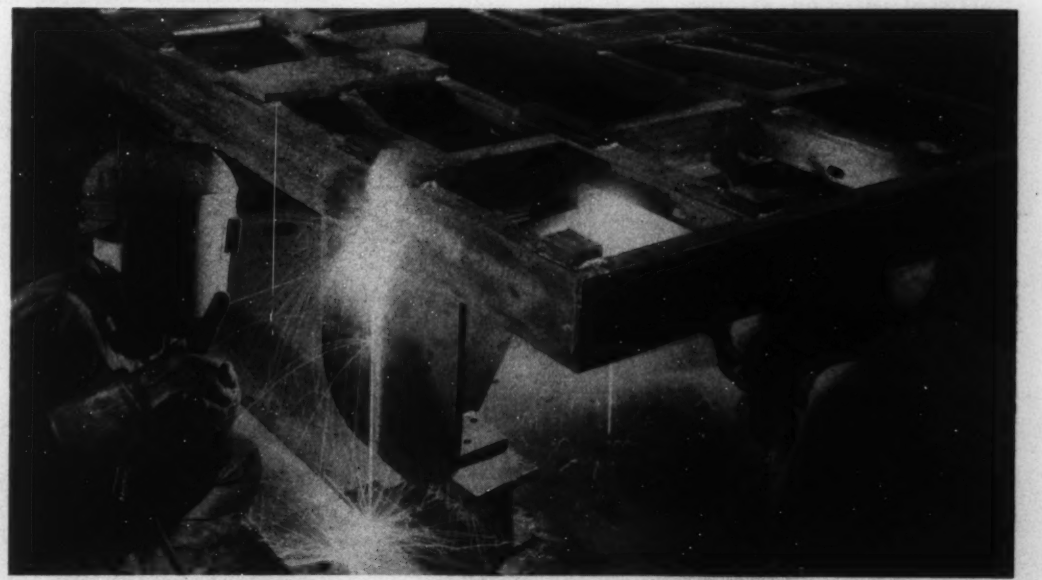


Fig. 4—Right—Arc welding a large machine frame with all-position electrodes which obviates turning the unit during fabrication

creates more warping and buckling with thin parts than is the case with arc welding.

All the various joints can be produced with gas welding and rods, with or without coating, are available to suit any joint or material. In general, forehand welding—with the torch pointed along the joint to be welded—is recommended for material up to $\frac{1}{8}$-inch in thickness, commonly termed sheet. For material greater than $\frac{1}{8}$-inch in thickness—specified as plate—backhand welding, with the torch pointed toward the metal just deposited, is recommended as it permits greater speed and control. Although either forehand or backhand welding of low-carbon or low-alloy steels can be done without protection, fluxes in the form of dry powder, paste, solutions, or rod coatings are generally utilized to eliminate oxides and prevent absorption of atmospheric gases during the deposition process. Automatic gas welding can be used in production and is best suited for the lighter gages of plate and for sheet materials.

Atomic-Hydrogen Welding: Utilizing two tungsten electrodes, the atomic-hydrogen process derives its welding heat directly from the dissociation of molecular hydrogen. The electric arc formed between the electrodes in an atmosphere of hydrogen transforms the gas into atomic hydrogen. Thus, the heat energy of the arc stream is transmitted to the weld zone, where upon striking the relatively cold plate surface a recombination of atoms results with release of heat energy. The hydrogen gas also performs the function of atmospheric protection for both the electrodes and the weld.

Method For Slag-Free Welds

This method can be used for practically any type weld. Operating costs are higher than for other methods but fluxes are rarely needed, except with aluminum, copper or their alloys and, consequently, the method is well suited for the formation of slag-free welds in heavy plate. It is used for welding light-gage steel and also for hard surfacing, *Fig.* 5.

Automatic atomic-hydrogen welders are also used but, as with all automatic equipment, are generally restricted to the welding of comparatively long straight seams or contoured seams which can be easily followed by automatic displacement of the welding head.

Thermit Welding: Probably least used of the methods of joining, thermit welding consists basically of welding by casting molten steel between abutting surfaces. Metallic aluminum powder mixed with iron oxide is ignited by burning magnesium powder in a crucible or mold prepared around the parts to be joined. Reduction of the iron oxide at the expense of the aluminum results in molten steel which flows between the prepared joint. The reaction takes about 30 seconds and results in an essentially stress-free weld with properties approaching those of forged steel.

Fig. 5—Above — Hard facing operation being done with an atomic-hydrogen welder

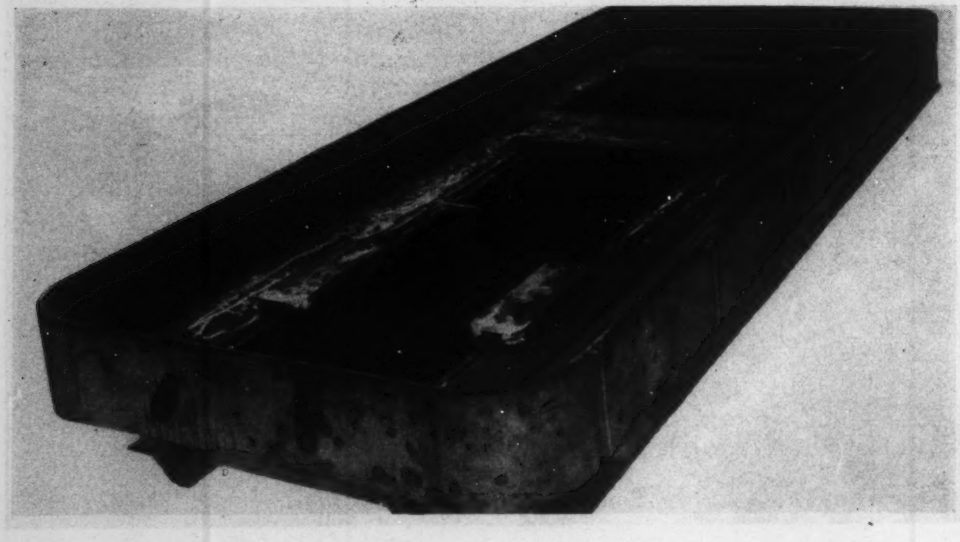


Fig. 6 — Left — Welded lathe bed. The bottom pan, inner pan and ends are press-brake formed on standard dies saving approximately 100 feet of welding

Thermit welding is advantageous in the welding of extremely large and heavy units not feasible with other methods. Preparation of parts is simple, surfaces as-cast or flame cut being satisfactory. Large forgings or castings too complicated for manufacture in one piece can be readily produced from several simple sections by thermit welded assembly and the need for stress relieving such sizable parts is eliminated.

Hard Facing: A hard, wear-resistant surface can be applied on almost any type part by any of the standard types of welding processes. A wide variety of hard surfacing materials in the form of welding rods is available and selection depends primarily upon the design and conditions. Gas welding permits close control and provides a smooth deposit while the electric arc process has the advantage of speed where quantity is involved. For large-quantity jobs, automatic machines have been widely employed. The primary advantage in design is the possibility of utilizing low-cost materials with hard faced wearing surfaces to conserve valuable metals and greatly reduce the cost of parts.

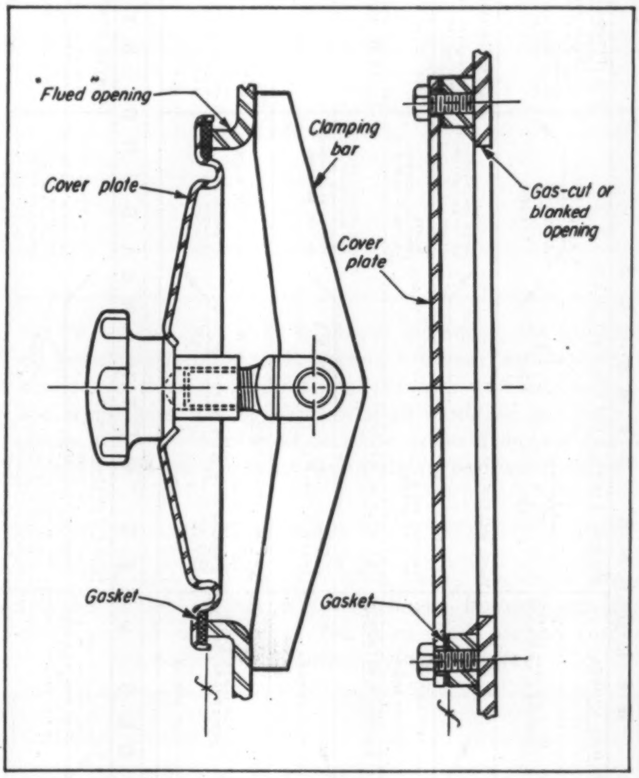


Fig. 7—Above—Press formed opening and cover provide a better coverplate design for stiffness than the conventional welded type with bolted construction

General Considerations: The economics of welded design for the most part are an individual problem with each manufacturer. Depending upon the facilities available, choice of a welding method may be limited or the materials which can be handled may be restricted. In the main, however, a few important considerations, regardless of these factors, should be kept in mind to obtain maximum economy in the design of welded components.

Design For Low Cost

Design in general should require a minimum of weld metal. Welding technique should be used to obtain the most economical results. A welded joint generally exceeds the cost of joints obtained by means of press bending, forming, or incorporating by means of castings, forgings or shapes, *Fig.* 6. Deposited metal ranges in cost from 70 cents to approximately 3 dollars per pound depending upon the size of joint and method of welding. The process and speed of welding have a considerable effect upon final welding cost. The cost per foot of joint can range (condering a 100 per cent operating factor) from ½-cent with thin sheet edge-welded by automatic carbon-

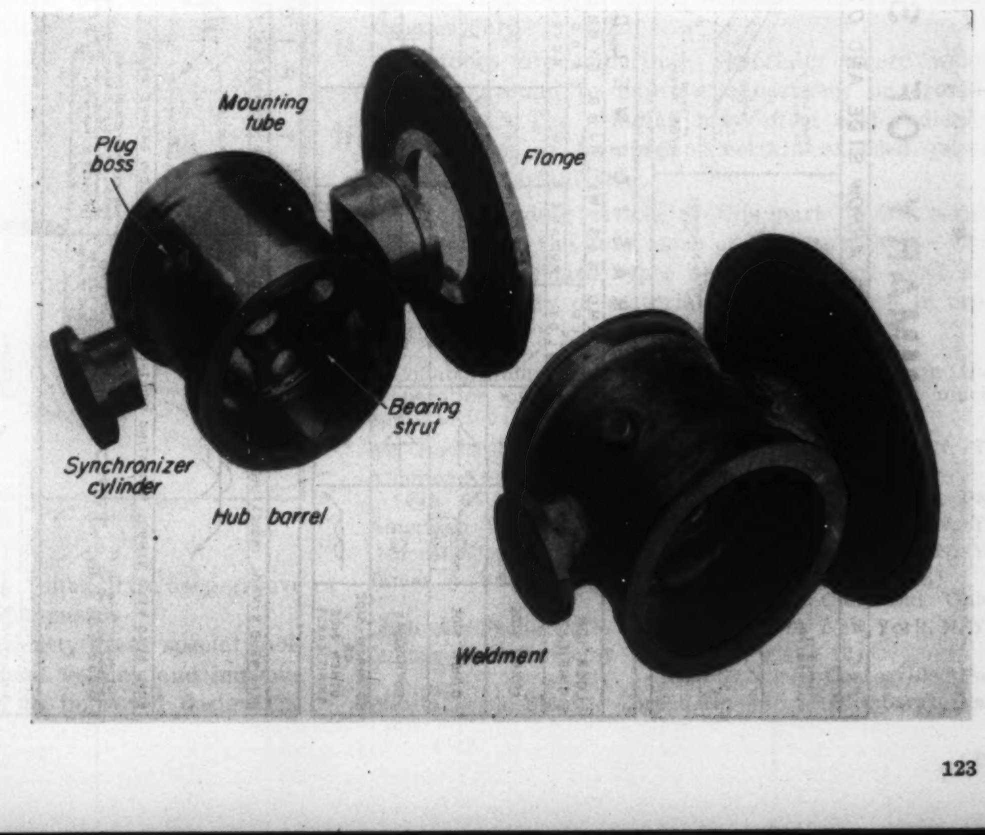
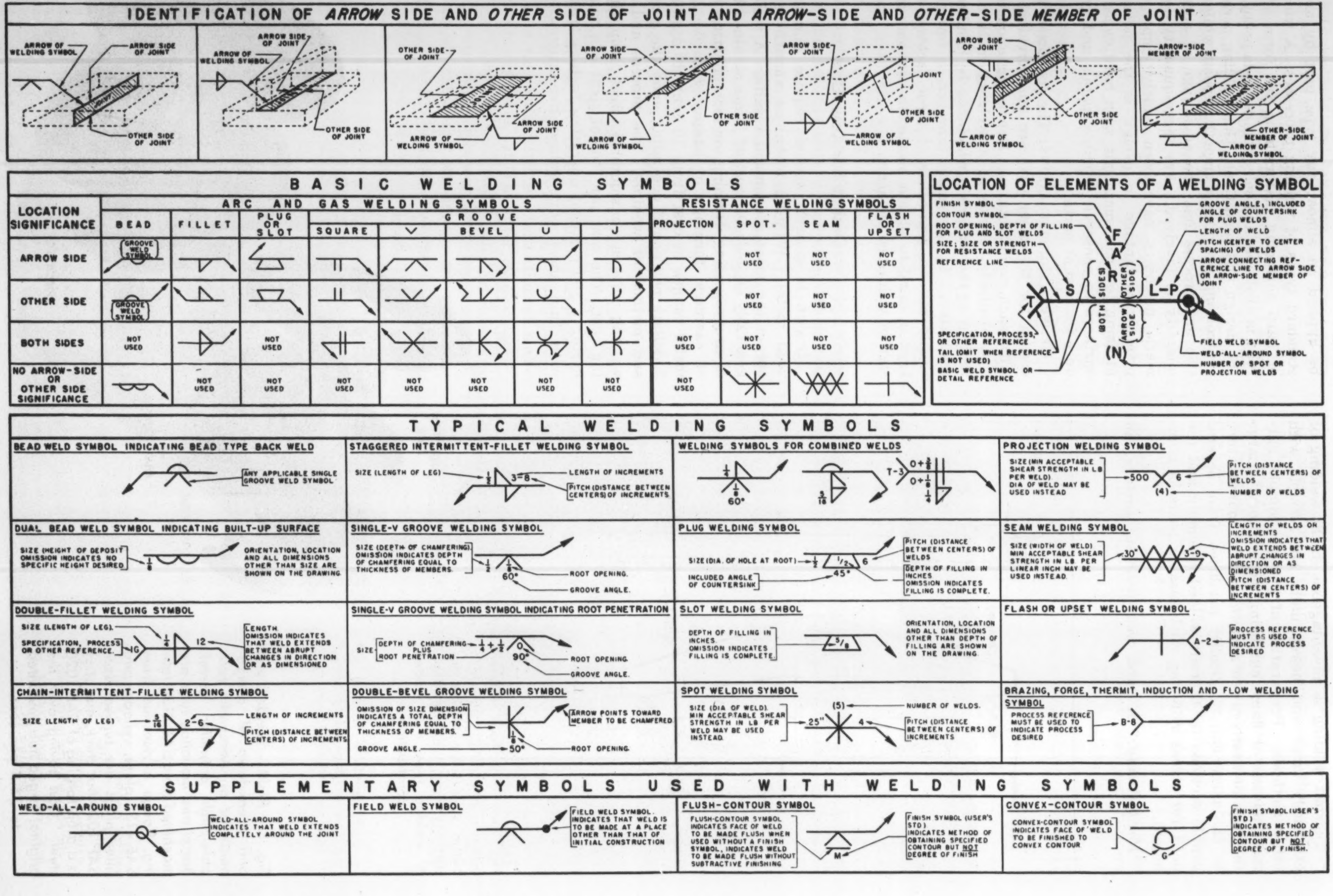
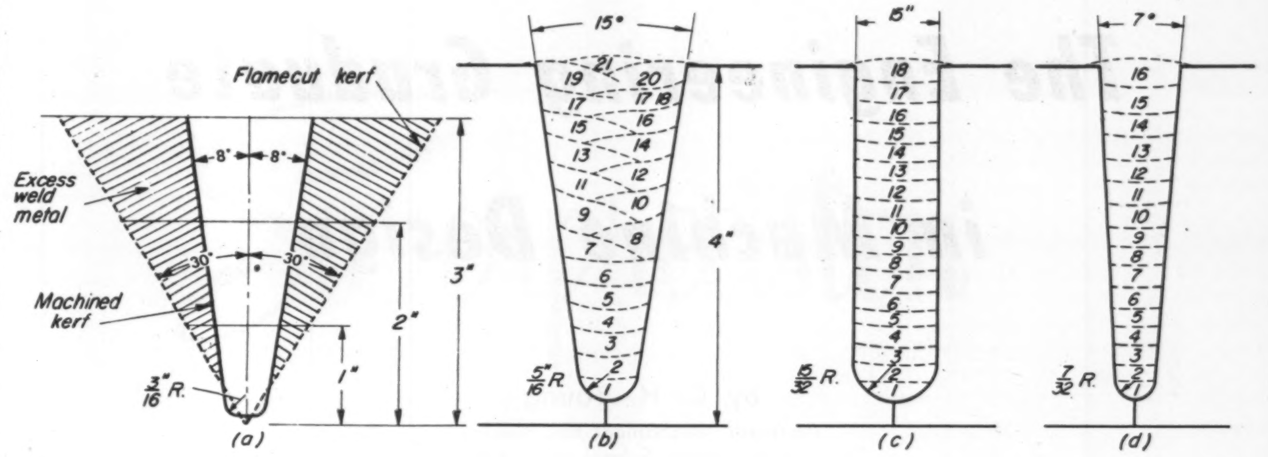


Fig. 8 — Right — Welded unit and breakdown of components for an Aeromatic variable-pitch propeller barrel. Barrel and mounting tube are machined from SAE 4130 tubing, flange is punched from SAE 4130 plate, cylinder and filler plugs are turned from SAE 1020 bar stock, and strut is a drop forging of SAE 1020 steel. Cost saving over the original forged hub amounted to 75.5 per cent

AMERICAN WELDING SOCIETY

SUMMARY OF STANDARD WELDING SYMBOLS

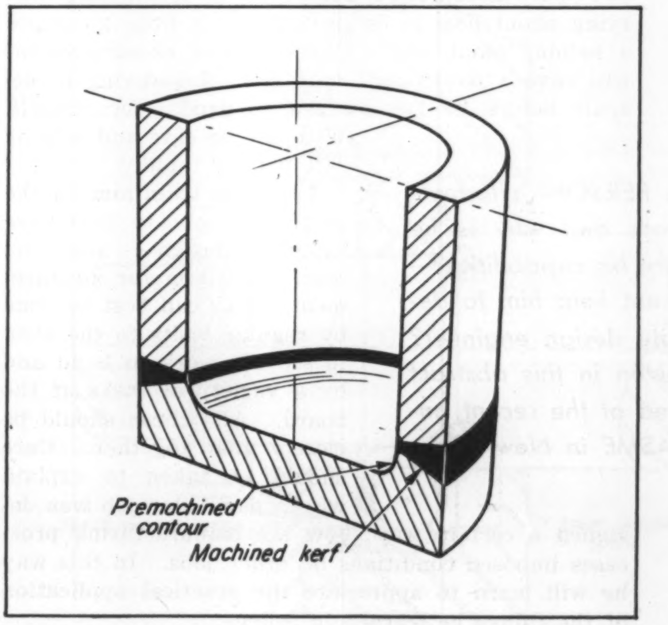

IDENTIFICATION OF ARROW SIDE AND OTHER SIDE OF JOINT AND ARROW-SIDE AND OTHER-SIDE MEMBER OF JOINT
ARROW OF WELDING SYMBOL
ARROW SIDE OF JOINT
OTHER SIDE OF JOINT
JOINT
ARROW-SIDE MEMBER OF JOINT
OTHER-SIDE MEMBER OF JOINT
BASIC WELDING SYMBOLS
LOCATION SIGNIFICANCE
ARC AND GAS WELDING SYMBOLS
RESISTANCE WELDING SYMBOLS
BEAD
FILLET
PLUG OR SLOT
GROOVE
SQUARE
V
BEVEL
U
J
PROJECTION
SPOT
SEAM
FLASH OR UPSET
ARROW SIDE
OTHER SIDE
BOTH SIDES
NO ARROW-SIDE OR OTHER SIDE SIGNIFICANCE
GROOVE WELD SYMBOL
NOT USED
LOCATION OF ELEMENTS OF A WELDING SYMBOL
FINISH SYMBOL
CONTOUR SYMBOL
ROOT OPENING; DEPTH OF FILLING FOR PLUG AND SLOT WELDS
SIZE; SIZE OR STRENGTH FOR RESISTANCE WELDS
REFERENCE LINE
SPECIFICATION, PROCESS, OR OTHER REFERENCE
TAIL (OMIT WHEN REFERENCE IS NOT USED)
BASIC WELD SYMBOL OR DETAIL REFERENCE
GROOVE ANGLE, INCLUDED ANGLE OF COUNTERSINK FOR PLUG WELDS
LENGTH OF WELD
PITCH (CENTER TO CENTER SPACING) OF WELDS
ARROW CONNECTING REFERENCE LINE TO ARROW SIDE OR ARROW-SIDE MEMBER OF JOINT
FIELD WELD SYMBOL
WELD-ALL-AROUND SYMBOL
NUMBER OF SPOT OR PROJECTION WELDS
F
A
R
S
T
L-P
(N)
(BOTH SIDES)
(OTHER SIDE)
(ARROW SIDE)
TYPICAL WELDING SYMBOLS
BEAD WELD SYMBOL INDICATING BEAD TYPE BACK WELD
ANY APPLICABLE SINGLE GROOVE WELD SYMBOL
STAGGERED INTERMITTENT-FILLET WELDING SYMBOL
SIZE (LENGTH OF LEG)
1/2
3-8
LENGTH OF INCREMENTS
PITCH (DISTANCE BETWEEN CENTERS) OF INCREMENTS
WELDING SYMBOLS FOR COMBINED WELDS
1/4
1/8
60°
5/16
T-3
0+3/8
0+1/8
1/4
PROJECTION WELDING SYMBOL
SIZE (MIN ACCEPTABLE SHEAR STRENGTH IN LB PER WELD). DIA OF WELD MAY BE USED INSTEAD
500
6
(4)
PITCH (DISTANCE BETWEEN CENTERS) OF WELDS
NUMBER OF WELDS
DUAL BEAD WELD SYMBOL INDICATING BUILT-UP SURFACE
SIZE (HEIGHT OF DEPOSIT OMISSION INDICATES NO SPECIFIC HEIGHT DESIRED
1/8
ORIENTATION, LOCATION AND ALL DIMENSIONS OTHER THAN SIZE ARE SHOWN ON THE DRAWING
SINGLE-V GROOVE WELDING SYMBOL
SIZE (DEPTH OF CHAMFERING). OMISSION INDICATES DEPTH OF CHAMFERING EQUAL TO THICKNESS OF MEMBERS.
1/2
1/8
60°
ROOT OPENING.
GROOVE ANGLE.
PLUG WELDING SYMBOL
SIZE (DIA. OF HOLE AT ROOT)
1/2
1/2
6
45°
INCLUDED ANGLE OF COUNTERSINK
PITCH (DISTANCE BETWEEN CENTERS) OF WELDS
DEPTH OF FILLING IN INCHES OMISSION INDICATES FILLING IS COMPLETE.
SEAM WELDING SYMBOL
SIZE (WIDTH OF WELD) MIN ACCEPTABLE SHEAR STRENGTH IN LB. PER LINEAR INCH MAY BE USED INSTEAD.
30"
3-9
LENGTH OF WELDS OR INCREMENTS OMISSION INDICATES THAT WELD EXTENDS BETWEEN ABRUPT CHANGES IN DIRECTION OR AS DIMENSIONED
PITCH (DISTANCE BETWEEN CENTERS) OF INCREMENTS
DOUBLE-FILLET WELDING SYMBOL
SIZE (LENGTH OF LEG).
SPECIFICATION, PROCESS OR OTHER REFERENCE.
1G
1/4
12
LENGTH. OMISSION INDICATES THAT WELD EXTENDS BETWEEN ABRUPT CHANGES IN DIRECTION OR AS DIMENSIONED
SINGLE-V GROOVE WELDING SYMBOL INDICATING ROOT PENETRATION
SIZE
DEPTH OF CHAMFERING PLUS ROOT PENETRATION
1/4 + 1/2
0
90°
ROOT OPENING.
GROOVE ANGLE.
SLOT WELDING SYMBOL
DEPTH OF FILLING IN INCHES. OMISSION INDICATES FILLING IS COMPLETE.
5/8
ORIENTATION, LOCATION AND ALL DIMENSIONS OTHER THAN DEPTH OF FILLING ARE SHOWN ON THE DRAWING.
FLASH OR UPSET WELDING SYMBOL
A-2
PROCESS REFERENCE MUST BS USED TO INDICATE PROCESS DESIRED
CHAIN-INTERMITTENT-FILLET WELDING SYMBOL
SIZE (LENGTH OF LEG)
5/16
2-6
LENGTH OF INCREMENTS
PITCH (DISTANCE BETWEEN CENTERS) OF INCREMENTS
DOUBLE-BEVEL GROOVE WELDING SYMBOL
OMISSION OF SIZE DIMENSION INDICATES A TOTAL DEPTH OF CHAMFERING EQUAL TO THICKNESS OF MEMBERS.
GROOVE ANGLE.
1/8
50°
ARROW POINTS TOWARD MEMBER TO BE CHAMFERED
ROOT OPENING.
SPOT WELDING SYMBOL
SIZE (DIA OF WELD). MIN ACCEPTABLE SHEAR STRENGTH IN LB PER WELD MAY BE USED INSTEAD.
25"
(5)
4
NUMBER OF WELDS.
PITCH (DISTANCE BETWEEN CENTERS) OF INCREMENTS
BRAZING, FORGE, THERMIT, INDUCTION AND FLOW WELDING SYMBOL
PROCESS REFERENCE MUST BE USED TO INDICATE PROCESS DESIRED
B-8
SUPPLEMENTARY SYMBOLS USED WITH WELDING SYMBOLS
WELD-ALL-AROUND SYMBOL
WELD-ALL-AROUND SYMBOL INDICATES THAT WELD EXTENDS COMPLETELY AROUND THE JOINT
FIELD WELD SYMBOL
FIELD WELD SYMBOL. INDICATES THAT WELD IS TO BE MADE AT A PLACE OTHER THAN THAT OF INITIAL CONSTRUCTION
FLUSH-CONTOUR SYMBOL
FLUSH-CONTOUR SYMBOL INDICATES FACE OF WELD TO BE MADE FLUSH WHEN USED WITHOUT A FINISH SYMBOL, INDICATES WELD TO BE MADE FLUSH WITHOUT SUBTRACTIVE FINISHING
M
FINISH SYMBOL (USER'S STD) INDICATES METHOD OF OBTAINING SPECIFIED CONTOUR BUT NOT DEGREE OF FINISH
CONVEX-CONTOUR SYMBOL
CONVEX-CONTOUR SYMBOL INDICATES FACE OF WELD TO BE FINISHED TO CONVEX CONTOUR
G
FINISH SYMBOL (USER'S STD) INDICATES METHOD OF OBTAINING SPECIFIED CONTOUR BUT NOT DEGREE OF FINISH.



Joint	(b)	(c)	(d)
Rod req'd. #/ft.	13.2	11.8	7.7
Rod diam.	3/16 & 1/4	1/4	5/32 & 3/16
Net welding speed for 4" joint in./min.	0.45	0.44	0.625

Fig. 9—Above—As plate thickness increases, the amount of metal wasted (a) with V-kerfs becomes an important economical factor. Typical joint (b) used with submerged-arc welding is less economical than modified groove (c) which has been employed on plate up to 5 inches, or (d) which requires the least repositioning and weld metal

Fig. 10—Below—Cross secion of a heavy hydraulic press cylinder which utilizes a premachined bottom provides close control of fit-up at the joint and proper corner contours in the heavy cylinder bottom



arc, to as much as $5.00 with 2-inch plate deep-groove welded manually in multiple-passes.

Where production is sufficiently great special tooling can be employed to reduce welding and improve design, *Fig.* 7. In addition to improved design the possibility of drastic cost reduction must not be overlooked, *Fig.* 8. Again where joint fit-up is concerned, the cost of machined edges must be balanced against lower cost flame-cut edges as plate size increases, *Fig.* 9. In addition, processes such as the inert gas-shielded or submerged-arc produce joints with considerably less joint-preparation cost.

In the design of welded machine elements the weld preferably should be used as a key or taperlike joining member rather than the total stress carrier, particularly where dynamic stresses are involved. Designing to place groove welds in compression or tension rather than in shear or as a wedge provides an additional factor of safety in highly stressed parts, *Fig.* 10. As a rule, compression is preferable to tension on such welds. Fillet welds should carry shear stresses only.

Contours are important, especially where welds must be ground to improve appearance or provide clean lines. The grinding may effect cost radically and bending or forming of certain exposed joints may be more desirable.

The concluding article of this part of the series will appear in the June issue of MACHINE DESIGN and will cover standard types of joints, detail joint design, weldability of materials, and tolerances in production.

Collaboration of the following organizations in the preparation of this article is acknowledged with much appreciation:

Air Reduction Sales Co. .... New York, N. Y.
American Car & Foundry Co., Welded Products Div. (*Fig.* 6) .... Berwick, Pa.
American Welding Society .... New York, N. Y.
General Electric Co. (*Fig.* 5) .... Schenectady, N. Y.
James A. Lincoln Arc Welding Foundation (*Fig.* 8) .... Cleveland, Ohio
Linde Air Products Co. (*Figs.* 2, 3 and 9) New York, N. Y.
Lukens Steel Company (*Figs.* 1, 7, 9 and 10) .... Coatesville, Pa.
Westinghouse Electric Corp. (*Fig.* 4) ..... Pittsburgh, Pa.

The Engineering Graduate in Machine Design

By C. H. Young
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New York

TODAY'S well-rounded engineering graduate can step into any mechanical engineering job as a trainee. And this is just what we older men did when we graduated ten, twenty, thirty years ago. But he has had something that most of us lacked. The emphasis in all his learning has been on logical thinking and problem analysis. And by problems, I do not mean the examples that are assigned as homework or given on tests. He has been taught to define his problem, to assemble and analyze the data, to devise a satisfactory method of solution and to always check carefully the validity of his answer.

In today's engineering graduate you will *not* get a machine designer. True, he has had some classroom experience in such work. Such experience, depending on the school, will vary all the way from a one-semester course covering both kinematics and design to as much as five semesters with many additional hours of drawing board work. But I am not too worried about the clock hours he has spent on this particular subject. Rather I am concerned with his liking for the work and his overall ability. Consequently, he will need careful supervision and guidance for some time after he joins you, until he is familiar with your particular line of work, your policies and, yes, your idiosyncracies. If you want a man who can step into a particular job in your office, hire a man with that experience. Don't hire a recent college graduate. He will be a disappointment to you and it will be disastrous to him.

WHAT KIND OF A PERSON is today's engineering graduate and why is he that way? What are his capabilities?—How can management help him to develop into a capable design engineer? The answers are given in this abstract of a paper presented at the recent annual meeting of ASME in New York

You won't even get a good draftsman. We college educators do not know which men are going into machine design, so very little emphasis is placed on delineation in most colleges. He will know the fundamentals of good drafting and should be able to make a presentable sketch, but he will need a lot of drawing board practice. You will have to give him this experience and be patient with him.

This man you hire will be a strange animal, full of contradictions. You cannot expect him to be mature. He is young and has had a sheltered experience. He will not measure up to your ideas of a man who can be assigned responsible charge. He will have the appearance of being overconfident, yet at heart he will be timid. He will continually want someone to lead him by the hand simply because his past experience has necessitated that most problems be rather sharply defined for him. He will be courageous, but easily discouraged, and he will be continually worrying about how he is getting on. A little guidance, a helping hand, and a few words of encouragement will save a worthwhile man from floundering in despair before he has learned to paddle for himself. With proper care and help he will develop rapidly.

You must train him for the particular job—in this case machine design — and you *must* train him for advancement. This can best be done by regular visits to the shop to see the work in hand and by a variety of tasks at the board. And these should be closely tied together. Care should be taken to explain why a particular job was designed a certain way; how the manufacturing processes imposed conditions on other jobs. In this way he will learn to appreciate the practical application of the things he learned in college.

It will also encourage him if he has a rather clear picture of what the future holds for him in your organization. You should take pains to carefully outline the steps ahead, give him some idea of the time it will take and what such advancement will mean to him in money and prestige. He is not mercenary—

(Concluded on Page 184)

Superprecision Ball Bearings

By Thomas E. Rounds
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Part VI—Lubrication and Systems

PROPER consideration of lubrication requirements in the design and application of superprecision ball bearing systems in machines is of utmost importance. Attainment of the most trouble-free service life and satisfactory operation requires that the right method of lubrication as well as the right lubricant be employed. In general, lubrication systems used for ball bearings fall into three well defined categories. Briefly, these are: (1) Semisolid lubrication with grease, (2) liquid lubrication with oil, and (3) air-oil mist lubrication.

GREASE LUBRICATION: The simplest of these systems uses grease. A grease is defined as a semisolid composed of a saponified animal or vegetable oil compounded with a natural mineral and, in some cases, a synthetic oil. The quality of the product depends upon fulfillment of the following requirements:

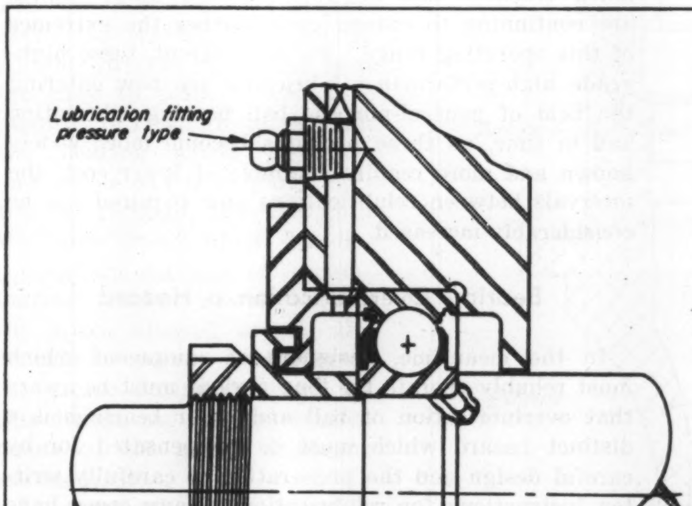

Fig. 36—Left—Design for a horizontal or vertical spindle using a single-shielded superprecision ball bearing for moderate speed and duty

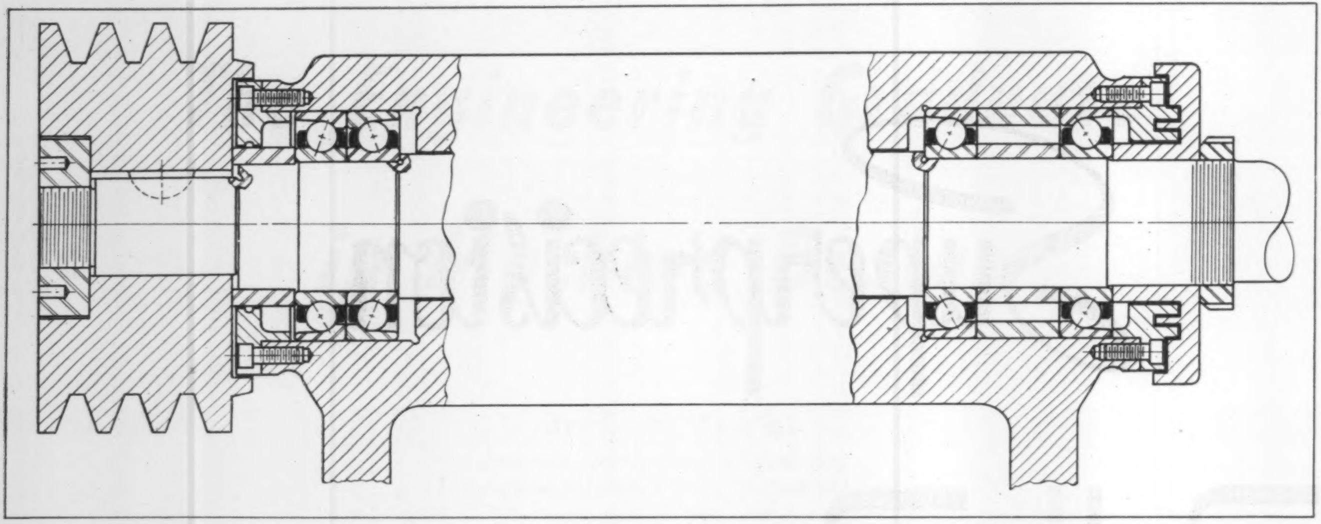

Fig. 37 — Multipurpose horizontal spindle design with sealed-in grease lubrication and no provision for subsequent relubrication

1. The resulting compound must be plastic and yield a supply of free oil in sufficient quantity to lubricate the bearing contact surface
2. The compound must remain stable in consistency and neutral chemically over long periods and through the required range of operating temperatures
3. The product must not separate into its main constituents of oil and soap
4. The product must be clean and free of damaging foreign materials.

Provided the above characteristics are met, grease lubrication will satisfy the majority of power operated applications even including the higher ranges of speed.

A wide variety of greases are available today for applications ranging from slow speeds and oscillatory motions using sleeve type bearings to very high speed precise applications using the highest grade superprecision ball bearings. Many grease products are entirely unsuitable for ball and roller bearings and relatively few brands or types satisfy the requirements of high performance ball and roller bearings.

Applications of antifriction bearings vary widely as to the "expected life" requirement. General-purpose motors and continuous-process machinery may be expected to operate without serious bearing trouble for several years or 5000 to 50,000 hours and longer. Generally, in such cases, means for periodic relubrication of the ball and roller bearings must be provided, since even if external contamination is entirely absent, the best of greases in time oxidize and deteriorate with regard to their lubricating properties. The higher the operating speed and temperature conditions, the shorter will be the grease life. On the other hand, there are many applications such as on aircraft accessories and very high-speed spindles where bearing life for various reasons may be expected to amount to but a few hundred or a few thousand hours. For such cases there are available ***high-grade grease lubricants*** which will satisfactorily perform with an initial charge and without need for relubrication.

Much improvement has been made in the quality of ball bearing grease lubricants particularly in the past ten years. This has largely resulted from the demands of the aircraft industry. Temperatures are frequently encountered running as low as −70 F to as high as plus 300 F. To secure satisfactory operation at such extremes of temperature has required much research and development and today efforts are continuing to extend even further the extremes of this operating range. To some extent, these high-grade high-performance lubricants are now entering the field of general-purpose ball bearing lubrication and in time, as these products become more widely known and more readily available at lower cost, the intervals between relubrications now required can be considerably increased.

Bearing Overlubrication a Hazard

In the meantime, designers of equipment which must reliably operate for long periods must be aware that overlubrication of ball and roller bearings is a distinct hazard which must be compensated for by careful design and the preparation of carefully written instructions for relubrication. Many cases have been recorded of excessive heating developed due to overzealous use of the grease gun which has resulted in the destruction of bearings, expensive replacement, interruption of processes and heavy damage to the products. For this reason many designers have made provision for grease storage and overflow. Instructions for relubrication should be written to make certain that users properly vent bearing housings when relubricating. This procedure will avoid the buiding up of excessive pressures and resultant churning of the lubricant with high temperature rise.

There are available pressure relief type grease fittings as well as metering systems, the latter supplying controlled quantities of lubricant which are known to be safe. Much has been published on this subject by bearing and equipment manufacturers as well as by leading suppliers of high-grade lubricants and lubricating devices.

In the field of superprecision bearing application, the life of the bearings may be limited by endurance qualities at high speed and high temperature and further influenced by unavoidable contamination of dirt and foreign matter. Life of the bearings therefore may in some cases actually be less than the life of the grease lubricant. Also, external contaminating hazards of grit, moisture and coolant may make relubrication of the bearings more hazardous to bearing life than no relubrication. For these reasons there is a definite trend toward "sealed" designs with built-in grease lubrication for the ball bearings. These designs may use plain unshielded bearings with elaborate shaft sealing or use single or double-shielded bearings with less complicated sealing devices. The intent of such designs is to discourage or even prohibit the user from adding improper lubricants and thereby contaminating the bearings with foreign matter and other deleterious substances.

A few typical mountings will illustrate the foregoing discussion. In *Fig.* 36 is shown a horizontal or vertical shaft mounting using a single shielded superprecision bearing. Since moderate speed, temperature and duty together with long bearing life is expected, provision for relubrication is provided through a conventional grease fitting and drilled passages. Pressure is built up in the space above the bearing with two resultant effects. The first is a tendency to force a moderate quantity of fresh grease through the bearing shield clearance and the second is to purge outwardly through the labyrinth seal some grease which will discourage the entrance of contaminating foreign matter. Note the space allowed beyond the bearing to permit expansion of the grease during running. In this design, the quality requirements of the grease lubricant are moderate.

In cases where considerable change in temperature is encountered between periods of operation and shutdown, it has been found desirable to exclude as far as possible large air volumes within the housing. Large voids or air spaces within bearing housings have in some cases, caused the entrance of foreign material into the bearing on cooling following shutdown. After a number of such cycles of shutdown and operation, bearings have worn to such an extent as to require renewal.

Minimizing Large Air Spaces

To avoid such conditions, spindles for normal temperature conditions (below 150 F running temperature) are designed along the lines shown in *Fig.* 37. Note that the air voids within the spindle have been kept to a minimum. This procedure will avoid the tendency mentioned in the above paragraph for foreign matter to be drawn into the housing following shutdown and cooling of the entrained air. The usual practice is to lubricate so that the air voids within the housing are approximately ¾ full of grease. The spindle is "run-in" for several hours and the temperature observed. Should the spindle overheat, checks are made and the quantity of grease is reduced or other mechanical difficulties cleared to eliminate the heating. Evidence is accumulating that spindles which run cool on trial, run well and per-

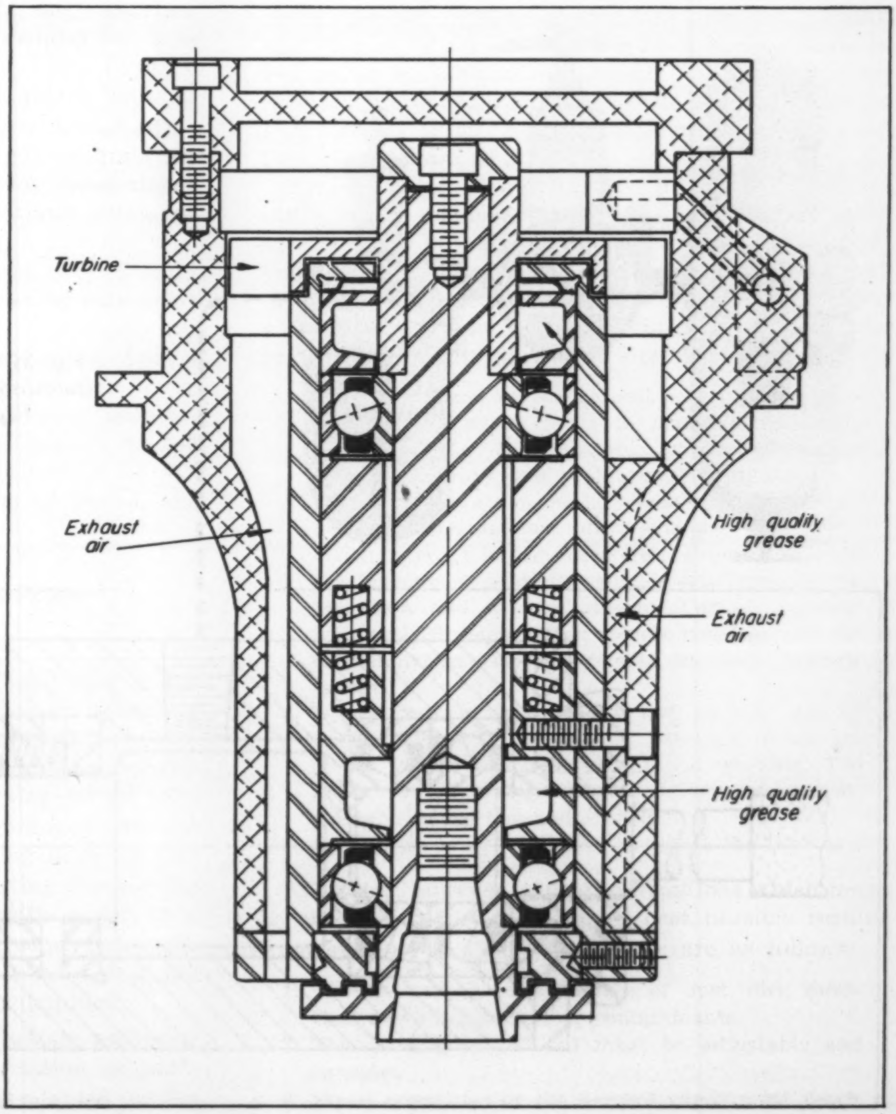

Fig. 38 — Air-turbine driven jig grinder spindle for vertical operation at 50,000 rpm with sealed-in grease lubrication. Drawing, courtesy Moore Special Tool Co.

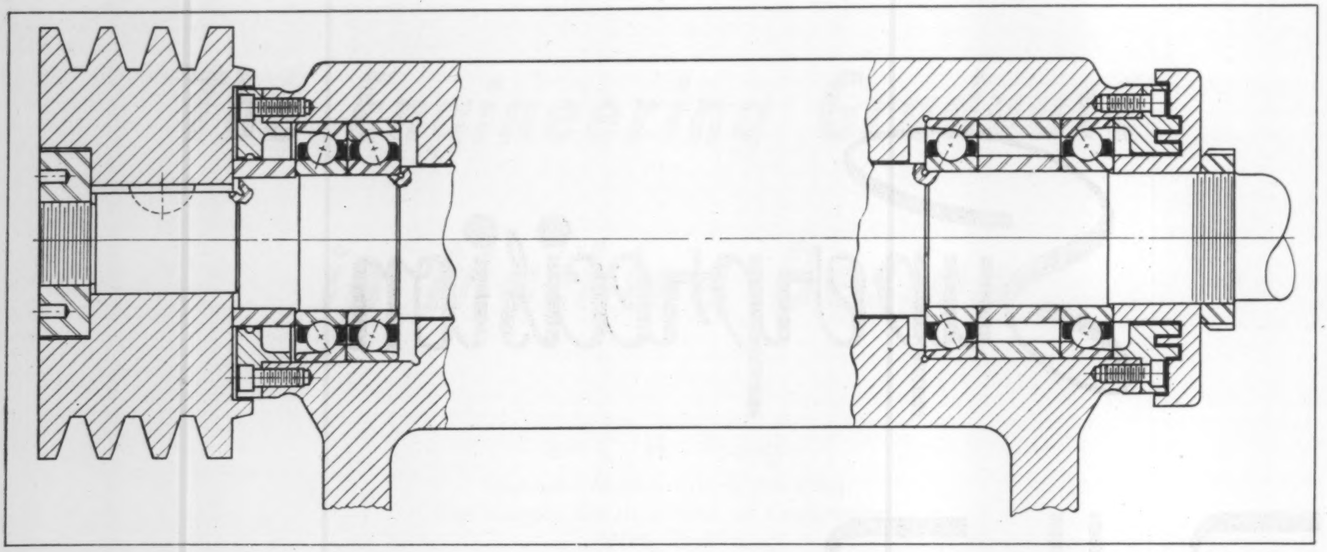

Fig. 37 — Multipurpose horizontal spindle design with sealed-in grease lubrication and no provision for subsequent relubrication

1. The resulting compound must be plastic and yield a supply of free oil in sufficient quantity to lubricate the bearing contact surface
2. The compound must remain stable in consistency and neutral chemically over long periods and through the required range of operating temperatures
3. The product must not separate into its main constituents of oil and soap
4. The product must be clean and free of damaging foreign materials.

Provided the above characteristics are met, grease lubrication will satisfy the majority of power operated applications even including the higher ranges of speed.

A wide variety of greases are available today for applications ranging from slow speeds and oscillatory motions using sleeve type bearings to very high speed precise applications using the highest grade superprecision ball bearings. Many grease products are entirely unsuitable for ball and roller bearings and relatively few brands or types satisfy the requirements of high performance ball and roller bearings.

Applications of antifriction bearings vary widely as to the "expected life" requirement. General-purpose motors and continuous-process machinery may be expected to operate without serious bearing trouble for several years or 5000 to 50,000 hours and longer. Generally, in such cases, means for periodic relubrication of the ball and roller bearings must be provided, since even if external contamination is entirely absent, the best of greases in time oxidize and deteriorate with regard to their lubricating properties. The higher the operating speed and temperature conditions, the shorter will be the grease life. On the other hand, there are many applications such as on aircraft accessories and very high-speed spindles where bearing life for various reasons may be expected to amount to but a few hundred or a few thousand hours. For such cases there are available ***high-grade grease lubricants*** which will satisfactorily perform with an initial charge and without need for relubrication.

Much improvement has been made in the quality of ball bearing grease lubricants particularly in the past ten years. This has largely resulted from the demands of the aircraft industry. Temperatures are frequently encountered running as low as −70 F to as high as plus 300 F. To secure satisfactory operation at such extremes of temperature has required much research and development and today efforts are continuing to extend even further the extremes of this operating range. To some extent, these high-grade high-performance lubricants are now entering the field of general-purpose ball bearing lubrication and in time, as these products become more widely known and more readily available at lower cost, the intervals between relubrications now required can be considerably increased.

Bearing Overlubrication a Hazard

In the meantime, designers of equipment which must reliably operate for long periods must be aware that overlubrication of ball and roller bearings is a distinct hazard which must be compensated for by careful design and the preparation of carefully written instructions for relubrication. Many cases have been recorded of excessive heating developed due to overzealous use of the grease gun which has resulted in the destruction of bearings, expensive replacement, interruption of processes and heavy damage to the products. For this reason many designers have made provision for grease storage and overflow. Instructions for relubrication should be written to make certain that users properly vent bearing housings when relubricating. This procedure will avoid the buiding up of excessive pressures and resultant churning of the lubricant with high temperature rise.

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Minimizing Large Air Spaces

To avoid such conditions, spindles for normal temperature conditions (below 150 F running temperature) are designed along the lines shown in *Fig.* 37. Note that the air voids within the spindle have been kept to a minimum. This procedure will avoid the tendency mentioned in the above paragraph for foreign matter to be drawn into the housing following shutdown and cooling of the entrained air. The usual practice is to lubricate so that the air voids within the housing are approximately ¾ full of grease. The spindle is "run-in" for several hours and the temperature observed. Should the spindle overheat, checks are made and the quantity of grease is reduced or other mechanical difficulties cleared to eliminate the heating. Evidence is accumulating that spindles which run cool on trial, run well and per-

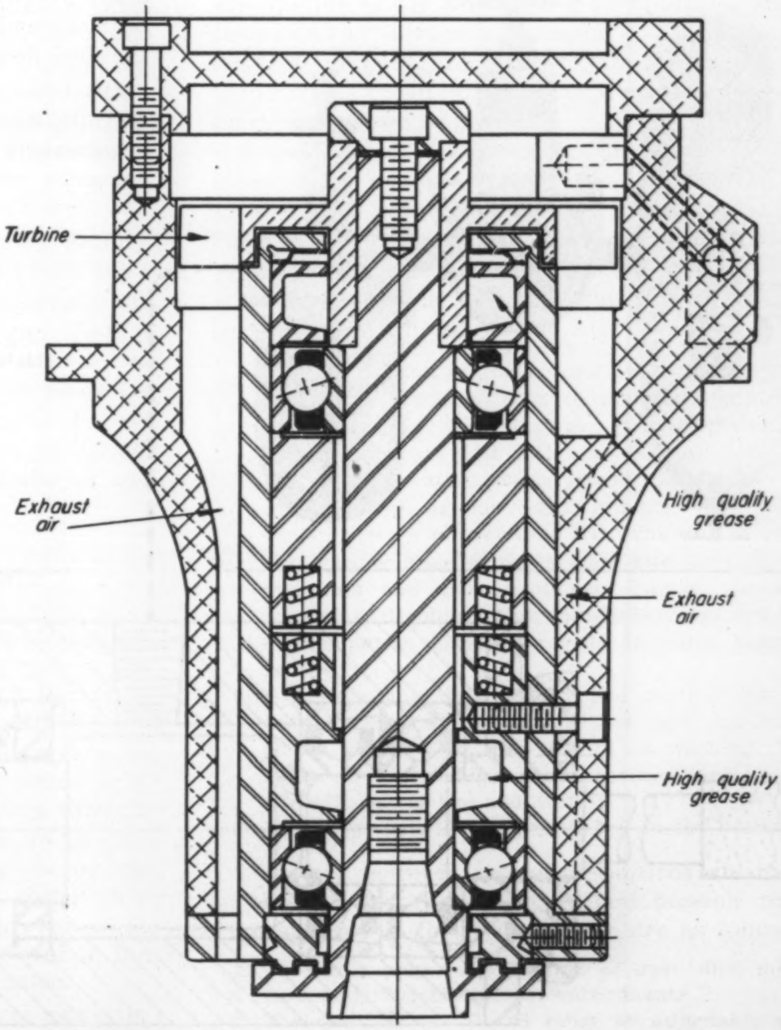


Fig. 38 — Air-turbine driven jig grinder spindle for vertical operation at 50,000 rpm with sealed-in grease lubrication. Drawing, courtesy Moore Special Tool Co.

form satisfactorily for thousands of hours without any further relubrication. For such sealed-in initial lubrication, obviously a high-grade grease lubricant is required.

Another method for grease lubricating high-speed spindles of relatively small size is shown in *Fig.* 38. In this case, the unit runs at uniformly low temperatures (usually below 90 F) since it is air turbine driven and ample cooling is provided by the expanding air passing through passages around the bearings. No problem of air contraction at shutdown is involved; consequently, slight air voids within the bearings are no particular problem. Grease applied to annular spaces within the upper collar and the preload spacing collar provides lubrication lasting several thousands of hours. A high-precision labyrinth seal collar protection is used at the lower end. A high-grade grease lubricant is required for this application.

In using double-shielded ball bearings at high speeds, it is essential that nonmetallic composition ball retainers be used for reasons given in previous discussion (see Part I—Selection for High Speed). These retainers due to their smooth surfaces cause minimum grease agitation and result in minimum heat generation. Manufacturers of small portable tools and grinders are increasingly using such bearings lubricated at the bearing manufacturer's plant with an optimum quantity of high-grade grease. The shielding of the bearings and absence of relubrication provision has proven to be far less troublesome in service than previous experience with unshielded bearings which allows the user to relubricate with improper lubricants and, further, subject the bearings to dirt hazards.

In addition to high-speed portable tools, many applications of these double-shielded bearings are being made to aircraft motors, generators, gyroscopes, blowers, and compressors. In some cases speeds have approached 100,000 rpm with temperatures running close to 300 F. Successful results ranging from hundreds of hours at such extreme speeds to thousands of hours at medium-high speeds have been obtained.

Reference is made to TABLE II in Part I (Selection for High Speed) for permissible limits of speeds with grease lubrication. As mentioned previously, the required intervals between relubrication are variable and subject to experience factors. Users are urged to consult with both bearing and lubricant manufacturers before setting up relubrication schedules or adopting sealed-in "one shot" lubricated designs. A careful study of relative cost and endurance factors of both bearings and lubricants is a necessity before making the final design decision.

OIL LUBRICATION: While an oil bath system is not the simplest for lubricating ball bearings due to the requirement for more elaborate housing seals and the extra care needed to keep joints from leaking oil,

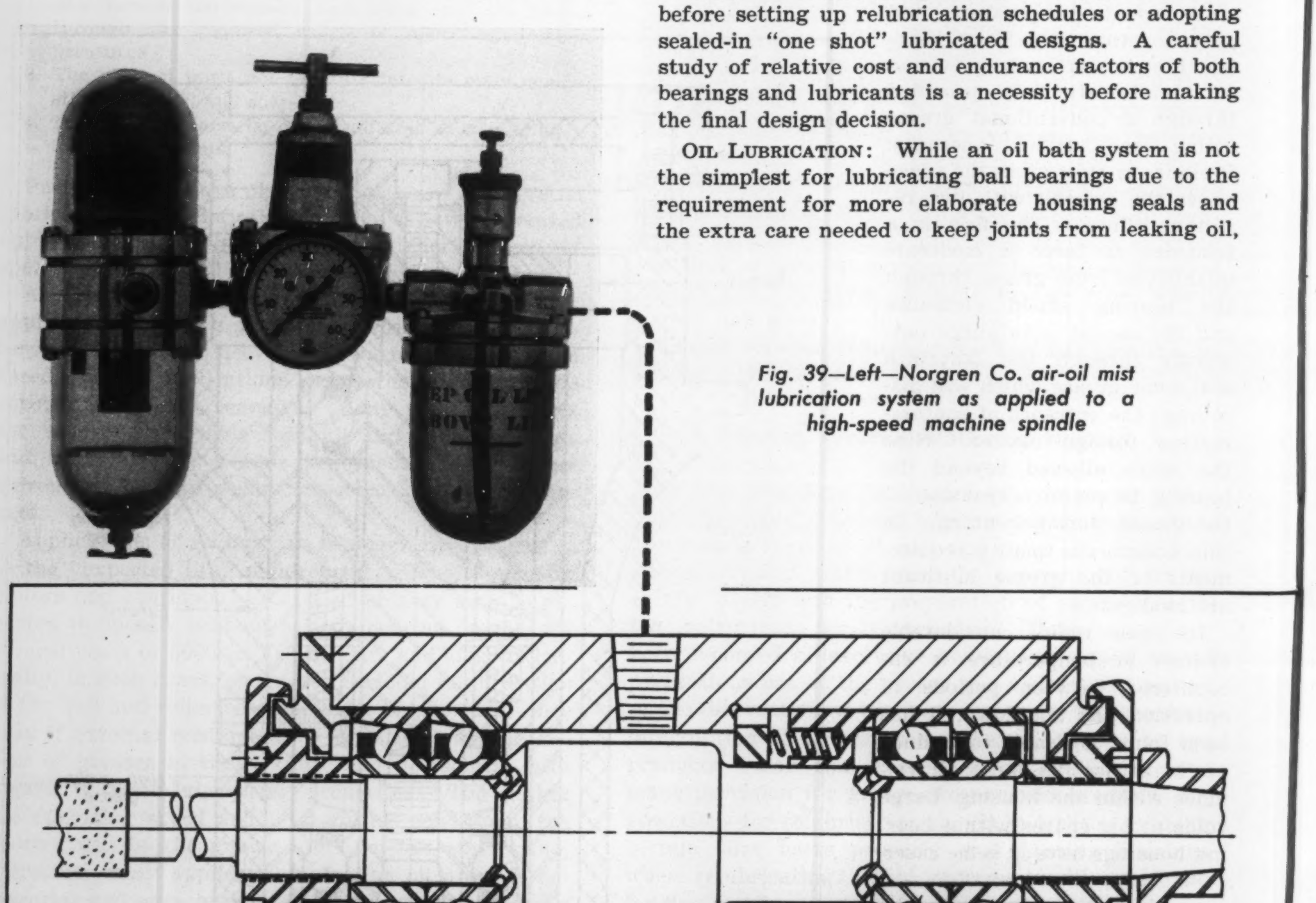


Fig. 39—Left—Norgren Co. air-oil mist lubrication system as applied to a high-speed machine spindle

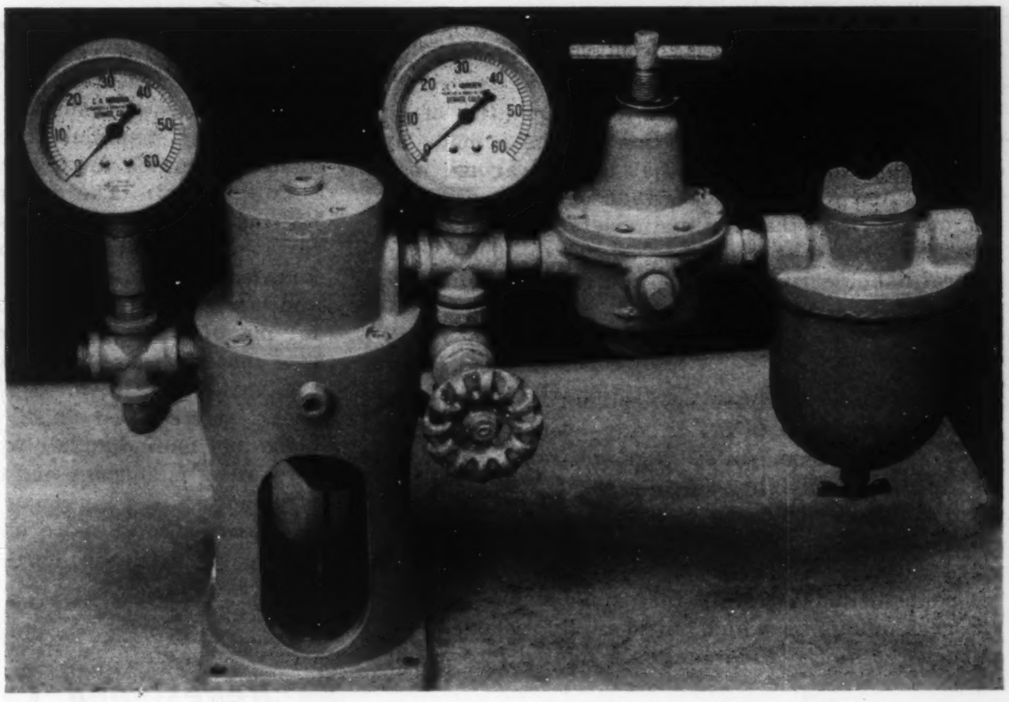


Fig. 40—Right — Heald Machine Co. air-oil mist lubrication equipment for application on high-speed ball bearing spindles

this system for some time generally has been considered to be the most reliable, particularly at high temperatures. Oils can be readily renewed by draining and replenishing. Oils will withstand higher temperatures for longer periods than will greases as they are essentially simpler products chemically. However, recent developments in improved grease lubricant products have narrowed the difference materially.

Methods of applying oil lubricants vary greatly. Instrument bearings are usually lubricated with a few drops from a hypodermic syringe and generally are not relubricated until the unit is over-hauled. Larger installations require oil reservoirs with cups to indicate level. At high speeds drip and wick feeds are used. However, oil bath or splash cannot be tolerated at speeds much above speed factors of 200,000 to 300,000 due to excessive agitation of the oil and resultant heating.

Flood Cooling Consumes Power

Where temperatures are high, either due to operating bearings at excessive speeds for their size or due to other causes, flood cooling with a large volume of oil pumped through the bearings may be the answer. However, flood cooling is liable to consume considerable additional power due to churning action arising from rotation of the balls and retainers through the oil. Therefore, when flood cooling is to be considered, the possibilities of refrigerating the cooling oil should not be overlooked since with cooler oil a lesser quantity of oil need be pumped which should, in turn, result in less churning of the lubricant in the bearings and less overall power consumption.

AIR-OIL MIST LUBRICATION: This system was originally designed for air cylinder lubrication on portable and other air tools. Later, it was adapted for the lubrication of high-speed grinding spindles. Today the mixture of air and oil in a finely divided state is known as a "lubricating aerosol." This lubrication medium is now regarded as separate and distinct from liquid forms of oil, as oil is different from semisolid lubricants known as greases.

Several types of systems are in use today which differ in the manner in which the liquid oil is finely atomized and mixed with the air stream. Various advantages are claimed for the various methods, but generally it is agreed that the following points explain why the air-oil mist system is superior to flood, drip or wick feeds for lubricating high-speed bearings.

1. The air portion of the aerosol constitutes a cooling medium which tends to maintain uniformly low operating temperatures, thus maintaining spindle accuracy and prolonged bearing life
2. Due to above atmospheric pressures used, foreign matter (such as dust, dirt, grinding grit, chips, coolants, etc.,) is prevented from entering through the housing seals of the spindle unit both during operation and after shutdown. Partial vacuums frequently develop within spindle housings and the contamination entering results in early bearing failure
3. By controlling the quantity and particle size of the oil droplets fed to the bearings, minimum power loss is developed due to oil working. Too much oil fed to high-speed bearings causes considerable power loss and heating
4. Only new, unused clean oil is fed to the bearings.

There are, however, several precautions which must be observed in order to secure best possible results from systems of this type. These are as follows:

1. The air supply must be free of dust, dirt, moisture, and other hazardous contaminants
2. The quantity of oil fed must be adjustable and constant
3. Equal quantities of the aerosol vapor must reach

all bearings to be lubricated and equally prevent all bearings from being contaminated through housing seals.

Various authorities differ as to the quantity of oil which should be used. Mention has been made by one bearing manufacturer that some bearings may be lubricated with much less than one drop per minute, others claim that for the moderate-size bearings, usually operated at speeds of 30,000 to 50,000 rpm, the rate should run from 3 to 10 drops per minute.

Low Air Pressures Used

Air pressures used are low, ranging from 10 to 20 pounds per square inch. In any event, the higher rates of feed seem to be more desirable from the standpoint of reliability as the cost of the oil used is small compared with the cost of replacing with new spindle bearings plus the down time and labor involved in cases of failure. Some experimentation is advisable to make certain that spindle temperatures are at a minimum which, incidentally, seems to result over a fairly wide range of limited-feed conditions.

Users, however, should observe a few simple precautions to make certain that conditions are correct. The length of piping between the lubricator and the spindle should be held to a minimum and the connection should be as straight as possible without bends, pockets or restrictions. Some vapors tend to condense out before reaching the bearings, thus causing difficulties associated with "slugs" of oil reaching the bearings at uncertain intervals causing uneven power loss and heating.

Thoroughly Atomized Oil Produced

In the two units shown in *Fig.* 39, the main elements consist of the following: (1) Air purifier and filter, (2) regulating valve, and (3) atomizing unit. This aerosol equipment is a Norgren unit which has been used at speeds up to 90,000 rpm and over. The air purifier is shown at the left. Air is introduced with a swirling action into the transparent plastic bowl where water particles are separated out. The air then passes through a fine-mesh screen for filtering and to the cotton moisture absorbing element immediately above. The regulating valve in the center then reduces and controls the pressure to the desired amount. At the right is the atomizing element with the oil reservoir at the bottom. Pressure created from the air-line flow forces oil through the filter tube up to the oil-control valve unit at the top. As oil drips down into the air stream it is blown against a baffle causing atomization and mixing with the air. Excessively large oil drops return to the reservoir and the air-oil mist (or aerosol) passes out to the spindle unit.

In *Fig.* 40 is shown the Heald unit also used successfully for speeds up to 90,000 rpm and over. In this case the air purifier is at the right. Next to the left is the regulating valve, pressure gage and at the extreme left is the atomizing unit and oil reservoir. In this unit the high-velocity clean air passing over the oil nozzle elevates the oil from the reservoir, converting it into a vapor and spray. The spray returns to the reservoir but the vapor is again mixed with a stream of clean air. The additional stream of air provides maximum cooling consistent with adequate lubrication for high speeds.

CONCLUSION: The design and manufacture of ball bearings and their successful application inevitably involves a study of many complex variables. As more knowledge is gained, the variables will be reduced and brought under better control. As the art of bearing manufacture progresses, variables associated with raw materials are constantly being reduced as are the variables associated with geometrical errors of shape and surface finish. Again, as users become more and more familiar with the most reliable types of bearing mountings and with the proper techniques of handling and servicing bearings, so will bearing operation become more and more reliable, resulting in greater accuracy, longer life, higher speeds, and lower friction.

Redesigned Cyclone Engines

EXPECTED to increase the top speed of the newly planned DC-3 twin-engine transport airliners by 25 per cent and to lower operating costs by 11 per cent, the first two models of a more powerful 9-cylinder aircraft engine have been delivered to the Douglas Aircraft Co. by Wright Aeronautical Corp. Designated the "Cyclone 9 HE", the new power plant produces almost 1500 hp but weighs less than 1400 pounds. The engine is an advanced version of the Cyclone 9 which has been used as standard equipment for many years on the original DC-2 and DC-3 airliners.

In addition to adding 45 mph to the speed of the plane, the new engines will increase the gross allowable weight from 25,200 to 27,300 pounds, enabling the aircraft to carry 28 passengers instead of the present 21. Quick loading facilities, new tail surface and wing sections, and strengthened landing gear capable of being completely retracted into the engine nacelles are among the revisions in the new DC-3.

Through an oversight the lead illustration which appeared on page 133 of the April issue of MACHINE DESIGN was not identified. The original from which the art rendering was produced and supplied through the courtesy of the Automatic Electric Co. of Chicago and shows a type 45 rotary switch.

They Say . . .

"Engineers should realize that basic engineering principles can be used to illustrate facts of human relationship and interest as a forceful and pertinent supplement to other interpretations more frequently heard from the pulpit and lecture platforms"—E. G. BAILEY, *president*, 1948, *of ASME*.

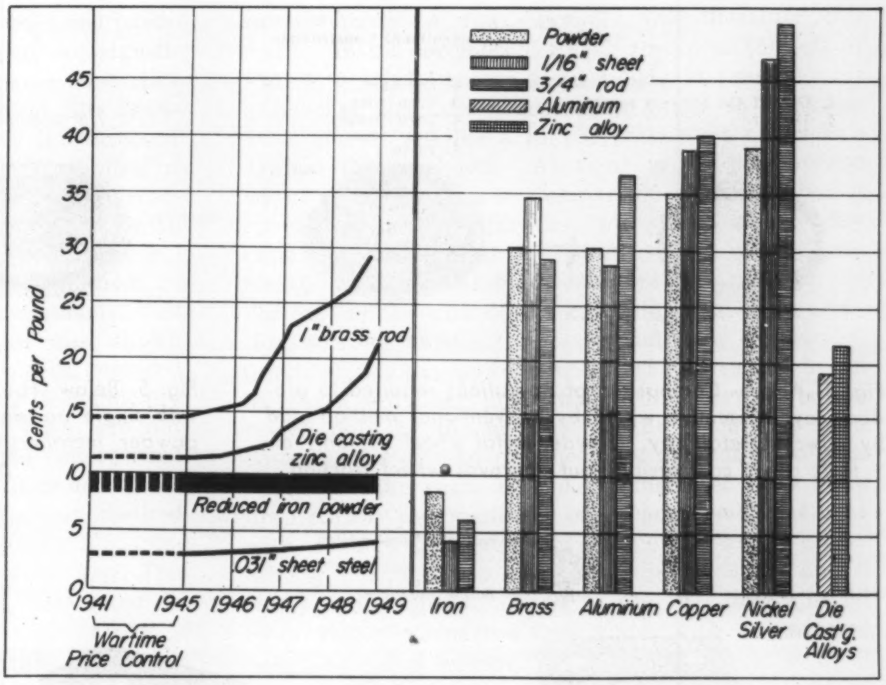


Fig. 1—Trends in costs, left, of metals used for small structural parts, and comparative costs, righ, of metal powders and rod and sheet stock

Dollars-and-Cents Advantages of Powder-Metal Parts

By Joseph L. Bonanno

Chief Engineer

The Lionel Corp., Irvington, N. J.

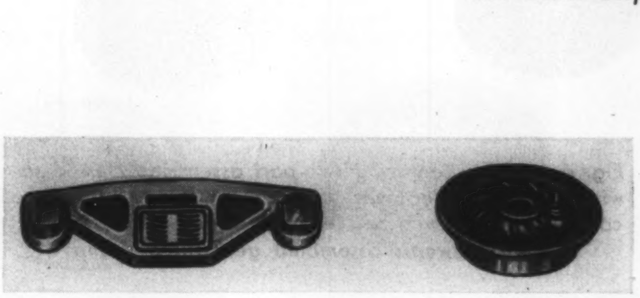


Fig. 2 — Above — Truck side, left, and car wheel, right, of toy locomotive are examples of profiled parts suited to short-run powder metal production

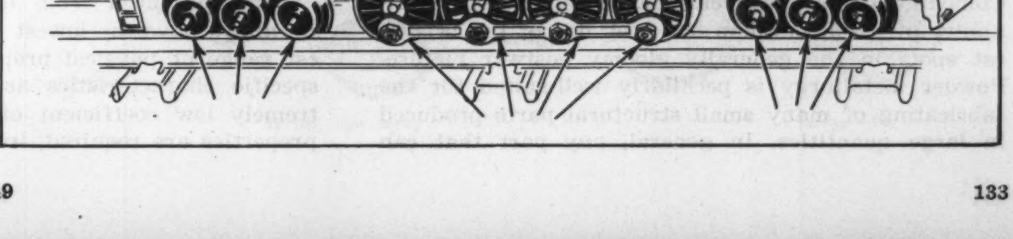


Fig. 3—Right—Some of the many powder-metal parts used in today's Lionel toy locomotives. Most of these parts have been converted to production by powder metallurgy since World War II

THERE'S a buyer's market coming, and in preparation for it sales departments are insistent on maintaining, or even reducing, prices in spite of rising material and labor costs. Designers who

Based on a paper presented at the fifth Annual Meeting and Exhibit of the Metal Powder Association in Chicago.

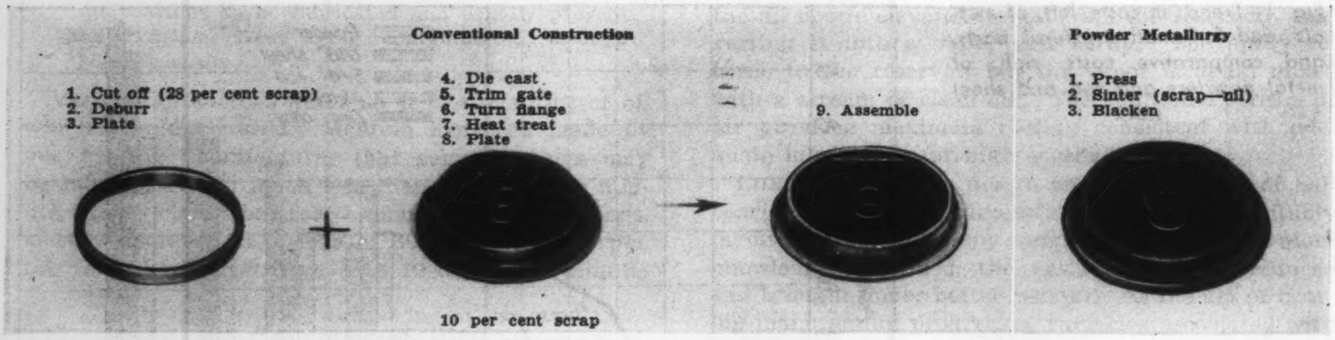

Conventional Construction
1. Cut off (28 per cent scrap)
2. Deburr
3. Plate
4. Die cast
5. Trim gate
6. Turn flange
7. Heat treat
8. Plate
10 per cent scrap
9. Assemble
Powder Metallurgy
1. Press
2. Sinter (scrap—nil)
3. Blacken

Fig. 4—Above—Comparison of operations required to produce toy locomotive wheel by conventional method and by powder metallurgy. Powder-metal wheel not only effects great cost savings but improves wheel traction

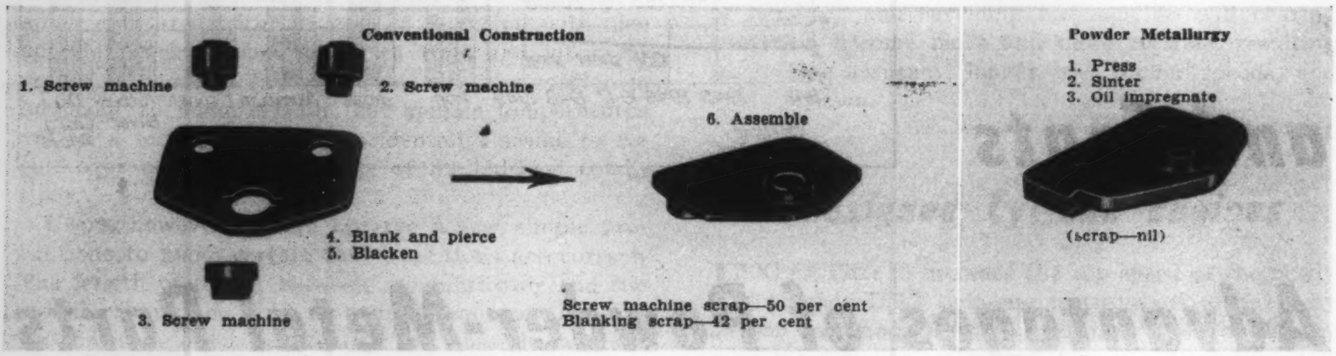

Conventional Construction
1. Screw machine
2. Screw machine
3. Screw machine
4. Blank and pierce
5. Blacken
6. Assemble
Screw machine scrap—50 per cent
Blanking scrap—42 per cent
Powder Metallurgy
1. Press
2. Sinter
3. Oil impregnate
(scrap—nil)

Fig. 5—Below—Four-piece bearing-plate assembly replaced with single powder-metal compact. Here, production by powder metallurgy eliminates scrap, reduces costs and produces a better part

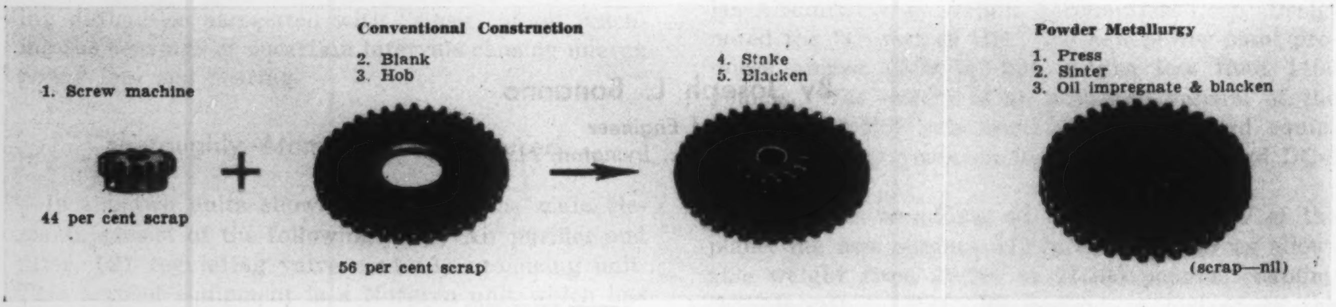

Conventional Construction
1. Screw machine
44 per cent scrap
2. Blank
3. Hob
56 per cent scrap
4. Stake
5. Blacken
Powder Metallurgy
1. Press
2. Sinter
3. Oil impregnate & blacken
(scrap—nil)

Fig. 6—Above—Replacing two-part assembled cluster gear with single powder-metal compact in this case reduced cost by seventy-seven per cent. In addition, powder-metal gear outwears assembled gear three-to-one

wish to produce competitive products must scrutinize all components more closely than ever before to determine the most advantageous and economical methods of fabrication.

The designer's problem is further complicated by the ever-changing supply situation of the various metals. Thus, in planning ahead, a wise designer must consider not only present costs but also future availability of raw materials. By proper selection of materials and manufacturing processes much redesign and attendant retooling expense can be avoided and production can continue uninterrupted.

For many designers, powder metallurgy has provided at least a partial answer to the twin problems of reducing costs and avoiding material scarcities. Compared to most conventional materials, the availability of metal powders has been one of the brightest spots in the generally gloomy postwar picture. Powder metallurgy is peculiarly well-suited for the fabricating of many small structural parts produced in large quantities. In general, any part that can be reduced to a simple pelleting operation can seldom be made as economically by any other method.

As can be seen in *Fig.* 1, iron powder today is the cheapest material of construction and, in contrast to the general upward trend in the metal market, has maintained a constant price level. During the period covered in the chart, the quality of powder from all sources has steadily improved. Recalling the prewar demand for a "good five-cent powder", one might say that, based on today's 60-cent dollar, the goal has been achieved.

Parts produced from iron powder and many of its alloys have the lowest material cost and the widest range of physical properties. Except where such specific characteristics as corrosion resistance, extremely low coefficient of friction, or nonmagnetic properties are required, iron powder is the first material considered by the designer of compacted parts. While the cost of most metal powders is not significantly different from the price of the same materials in rods and sheets (see *Fig.* 1) the scale tilts heavily in favor of powder when one takes into account the scrap losses involved in stamping or machining of small parts—a loss which becomes increasingly greater as the parts grow smaller. By comparison with conventional methods of manufacture, powder metallurgy may well be called the "scrapless" method.

Although powder metallurgy is particularly well suited to mass production, experience has shown that even quantities of a few hundred pieces, required for small production runs, can be made economically by this process if tooling and set-up costs are not unreasonably high. One such specialized "short run" application is the manufacture of plastic molds. Some profiled parts are so well adapted to this method of production that even smaller quantities can scarcely be made as economically in any other way. The toy locomotive truck side and wheel illustrated in *Fig.* 2 are examples.

Another example of studied application of powder metallurgy to a toy locomotive is shown in *Fig.* 3. With the exception of brushes, all parts indicated by arrows are postwar applications of powder metallurgy. In all, 34 individual parts of this locomotive are now produced by this process.

In converting to powder metallurgy, spectacular cost reductions and product improvements can sometimes be effected by designing single parts to replace subassemblies. A few examples will illustrate this point. In the locomotive wheel, shown at the left of *Fig.* 4, a steel tire cut from tubing is pressed over a die-cast zinc alloy locomotive wheel to minimize wear and to provide a higher coefficient of friction against the steel rail. At right is the powder-iron wheel which replaced it. Comparison of the number of operations required for the two wheels will readily show why the cost of this powder-metal wheel, completely finished and black oxidized, is less than 60 per cent of the cost of the zinc alloy alone. In addition, the 25 per cent higher coefficient of friction provided by the powder-metal wheel results in an increased draw-bar pull which can otherwise be attained only by the addition to the locomotive of a 35-cent slug of lead or zinc alloy for added weight.

The bearing plate in *Fig.* 5 illustrates even more dramatically the possibility of replacing subassemblies with a single compact. Here a powder-metal oil-retaining bushing, two screw-machined spacers and a stamped steel plate, shown at the left, are replaced by a single compacted iron plate, with an integral reduced-density bearing.

Varying Density Can Effect Savings

While the increased porosity of the bearing portion of the plate is used here because of its increased oil retentivity, the variable density of this part demonstrates another important feature of powder metallurgy. Structural parts seldom require uniform strength. In castings, this fact is recognized by varying the thickness of the sections. In powder metallurgy a similar effect can be obtained by decreasing the density of the portions of compacts where strength is not particularly required. Up to one-fourth of the weight can be saved by intentionally decreasing the density of the lightly stressed sections to the point where the green compacts can be handled without breakage.

Still another application of powder metallurgy is illustrated in *Fig.* 6. Here a pinion, cut on a screw machine from drawn pinion rod, is staked to a gear made by blanking and hobbing. The sintered-iron cluster gear replacing this assembly has closer tolerance in pitch diameter, less eccentricity, and is free of the unavoidable burr associated with the cutting-off operation performed on the pinion. Because of the cushioning and oil-retaining properties due to its inherent porosity, the pressed cluster gear outwore three assembled gears in a life test. By way of comparison, the cost is 77 per cent less.

Superiority of the pressed gear with its hard,

Fig. 7—Below—Die-cast spinner cup with bronze bushing and integrally cast bevel gear was replaced by molded plastic cup using a powder-metal combination gear and bearing as an insert

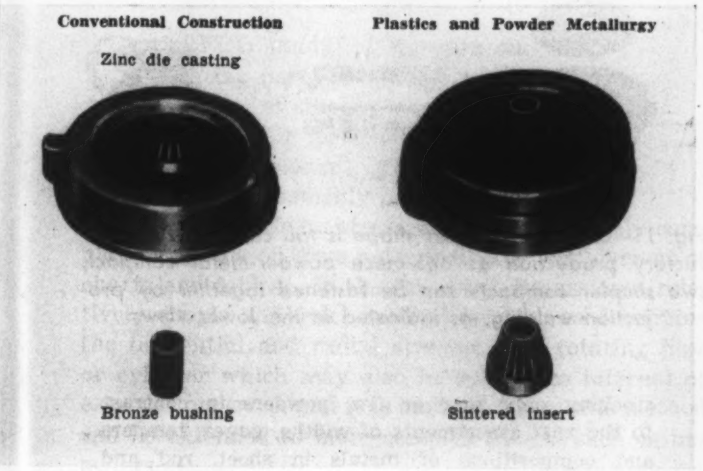
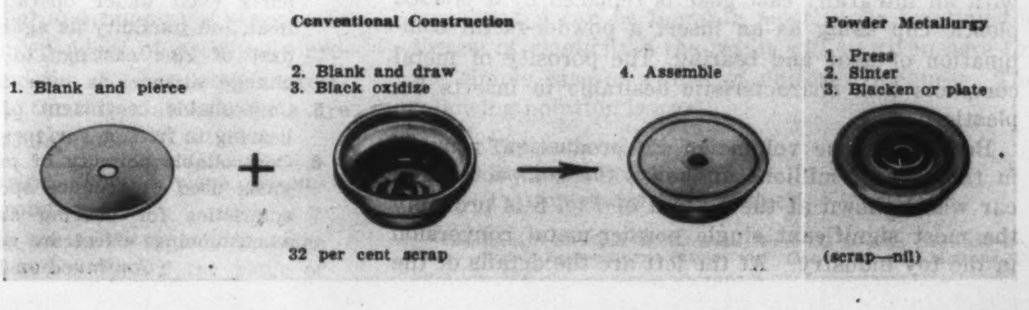


Fig. 8 — Right — Toy train wheels have long been fabricated from sheet metal. Conversion by Lionel to production by powder metallurgy has improved train performance and appearance and, in addition has eliminated scrap



dense teeth and porous hub has been clearly established. A notable advance has been made by the recent perfection of a method for pressing helical gears and pinions, so that the greater strength and quiet running characteristics inherent in the helical tooth form can now be incorporated even in the most inexpensive devices. A distinct field for powder metallurgy lies in production of special tooth shapes unattainable by the usual generating methods.

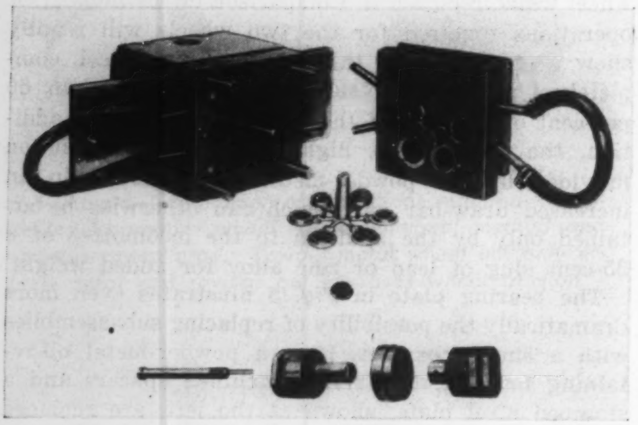


Fig. 9—Above—Die-casting die, top, and powder-metal tool, bottom, of equal productivity

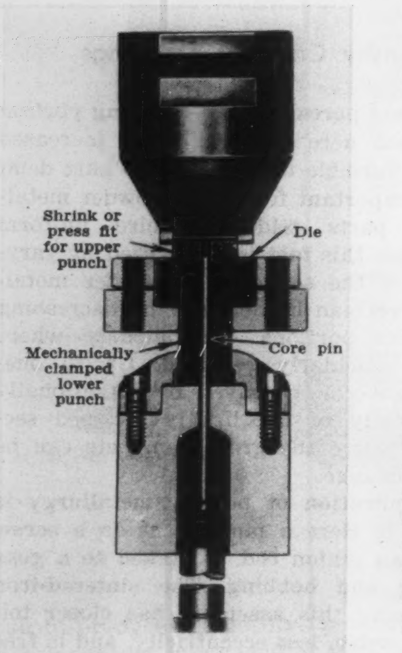

Shrink or press fit for upper punch
Die
Mechanically clamped lower punch
Core pin

Fig. 10 — Left — For large-quantity powder-metal production runs, tungsten-carbide dies are highly desirable. Cross section through dies, shows how lower punch is clamped in position

A somewhat unusual application of powder metallurgy is illustrated in *Fig.* 7 where a combination of a bronze bearing bushing and a die-cast spinner cup with an integrally cast gear is replaced by a molded plastic cup using as an insert a powder-metal combination of gear and bearing. The porosity of metal compacts is a characteristic desirable in inserts for plastic parts.

Because of the volume of its production, running in the tens of millions annually, the compacted-iron car wheel shown at the bottom of *Fig.* 8 is probably the most significant single powder-metal conversion in the toy industry. At the left are the details of the sheet-metal wheel construction used by the industry for the past 75 years. Besides the ready availability and low cost of iron powder, its use in toy car wheels immediately after the war released large tonnages of the then scarce sheet metal for other jobs. The entire model train was greatly improved by the lowered center of gravity due to the greater weight of the wheels and also by their trueness, uniformity and realistic appearance. These wheels are ordinarily black oxidized but where very low contact resistance is essential, as in radio frequency controlled trains, they are nickel plated through the use of a proprietary method of plating. In this method the troublesome residual salts which formerly had to be leached out by repeated washings, are volatilized by an annealing process. Salts which are not volatilized at the annealing temperatures are first converted to volatile salts by chemical treatment.

To summarize, some of the factors which have contributed to the cost reduction and improved performance of these and similar parts are:

1. Replacement of the zinc alloy for the competitive process of die casting by cheaper powdered iron
2. Greater availability of metal powders as compared to sheet, rod or bar stock of the same metals
3. Reduced raw material inventories resulting from stocking only four or five powders in contrast to the vast assortments of widths, gages, tempers and compositions of metals in sheet, rod and other special forms
4. Dimensional stability of sintered metal powder parts even under operating conditions of high heat and humidity as against the tendency on the part of zinc castings to disintegrate, warp and change dimensions over a period of time
5. Controllable coefficient of friction ranging from bearing to friction surfaces
6. Controllable porosity of pressings in localized regions used to produce special oil retaining characteristics for bearing surfaces and to provide a cushioning effect in gears, cams, levers, etc.

(*Continued on Page* 180)

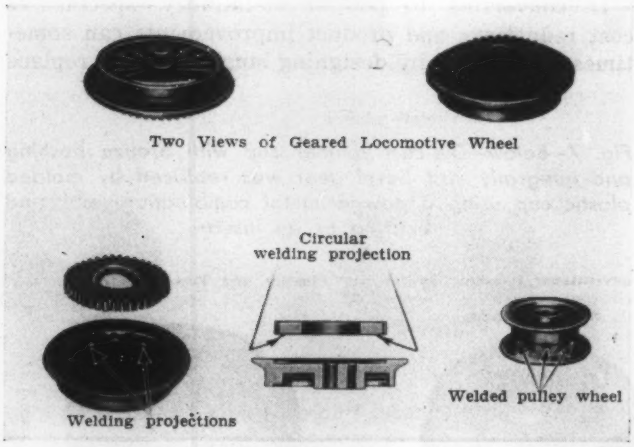

Two Views of Geared Locomotive Wheel
Circular welding projection
Welded pulley wheel
Welding projections

Fig. 11—Often where part shape is too complex for satisfactory production as one-piece powder-metal compact, two simpler compacts can be fastened together by projection welding, as indicated in the lower views

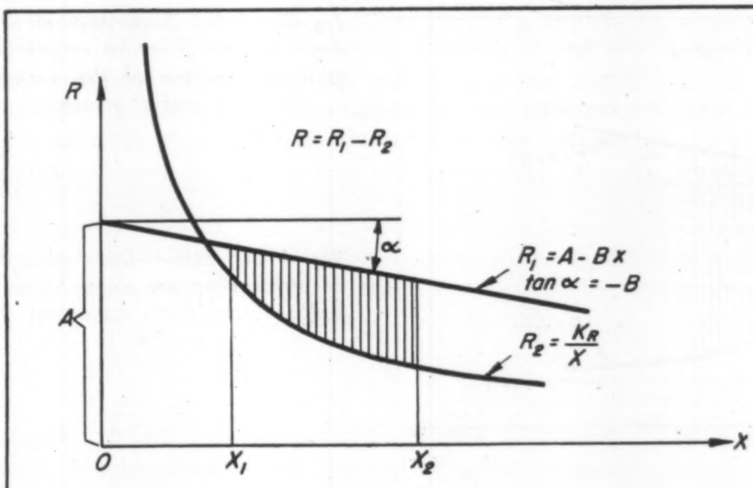


Fig. 1—Left—Radial stress in disk represented by ordinate between straight line with minus slope (R_1) and hyperbola (R_2)

Centrifugal Stresses in Disks

Graphical determination simplifies analysis

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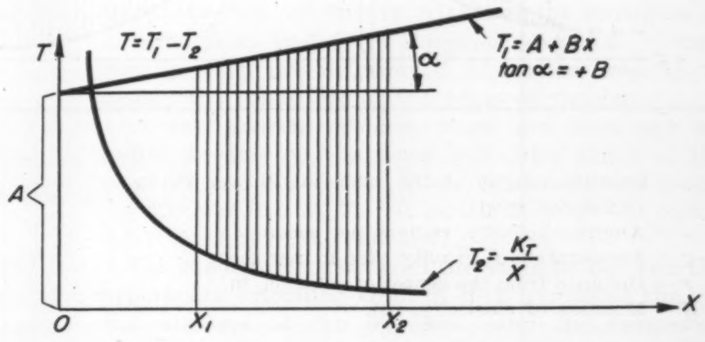

Fig. 2—Below—Tangential stress shown as ordinate between straight line with plus slope (T_1) and hyperbola (T_2)

CAREFUL study of stresses in rotating parts is of importance because of the general trend toward increasing peripheral speeds in rotating machines. The various methods more commonly presented to determine centrifugal stresses are comparatively complex and some of them necessitate the employment of charts and tables. In the following discussion a relatively simple and quick method is given to determine the tangential and radial stresses in a rotating disk or cylinder which may also be subject to internal or external pressure, and it is explained how this method can be extended to more complex shapes such as impellers.

The graphical method presented here is based on the results obtained from the fundamental derivation of the equations for radial and tangential stresses in a rotating disk. It is independent of previously prepared charts or tables and the stresses appear directly on the diagram. The fundamental equations are based on the following assumptions:

a. The disk is symmetrical about a plane perpendicular to the axis of rotation

b. Thickness of the disk varies so slightly that the slope of the radial stresses toward the plane of symmetry is negligible

c. Stresses are uniformly distributed around cylindrical planes co-axial with the center of rotation

d. The material is homogenous and strain and stress are proportional.

It should be noted that these assumptions are necessary for the mathematical derivation. For the practical application, however, it is permissible to depart considerably from these assumptions with only minor error in the final result.

Since the mathematical derivation is somewhat lengthy and can be found in most books treating the theory of elasticity,* the result will be given here for the simple case of a disk of uniform thickness. The following notation is used:

T = Tangential stress, psi
R = Radial stress, psi
μ = Poisson's ratio (0.3 for steel)

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*Timoshenko, *Strength of Materials*, Part II, D. Van Nostrand Co., 1941. Stodola-Loewenstein, *Steam and Gas Turbines*, McGraw-Hill Book Co., 1927.

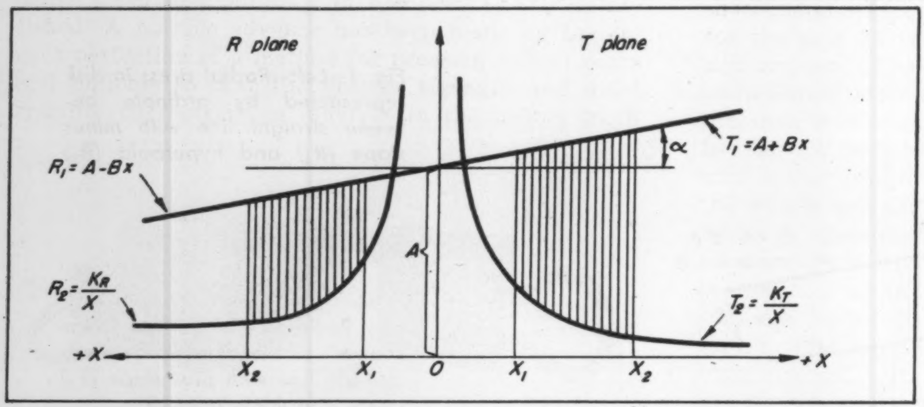


Fig. 3 — Left — Superposition of Figs. 1 and 2 while inverting positive direction of the x-axis for the radial stresses

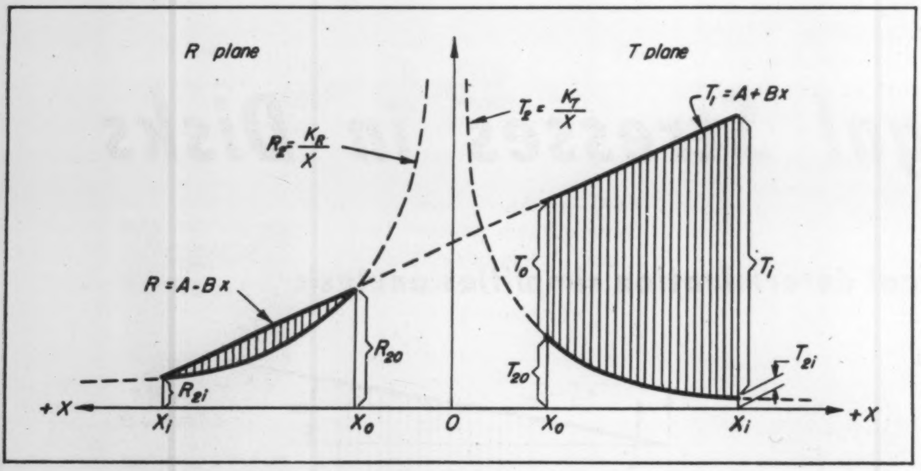


Fig. 4—Left Below—Development of stress diagram using hyperbolas found from Equations 3 and 4

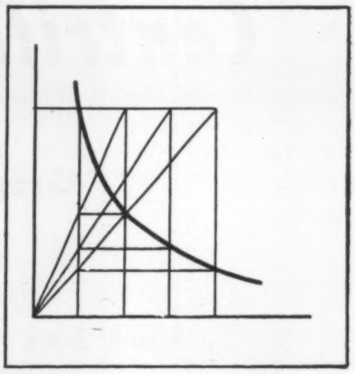


Fig. 5—Below—Method of tracing hyperbolas when complete stress picture is desired

γ = Specific weight of the material, lb per cu in., (0.286 for steel)
ω = Angular velocity, radians per second
g = Acceleration of gravity (386 in. per sec²)
r = Distance from the center of rotation, in.
E = Modulus of elasticity, psi.

The notations T and R rather than σ_t and σ_r were chosen in order to avoid subscripts and to simplify the presentation.

With the above notation the equations for the radial and tangential stresses for a disk of uniform thickness read as follows:

$$R = \frac{E}{1-\mu^2}\left[-\frac{3+\mu}{8}Nr^2 + (1+\mu)C_1 - (1-\mu)\frac{C_2}{r^2}\right] \quad (1)$$

$$T = \frac{E}{1-\mu^2}\left[-\frac{1+3\mu}{8}Nr^2 + (1+\mu)C_1 + (1-\mu)\frac{C_2}{r^2}\right] \quad (2)$$

In both Equations 1 and 2, and using the same notation as above,

$$N = (1-\mu^2)\frac{\gamma\omega^2}{gE}$$

and C_1 and C_2 are constants of integration. If the foregoing value of N is introduced in Equations 1 and 2,

$$R = -\frac{\gamma}{g}\frac{3+\mu}{8}\omega^2 r^2 + \frac{E}{1-\mu}C_1 - \frac{E}{1+\mu}C_2\frac{1}{r^2}$$

$$T = -\frac{\gamma}{g}\frac{1+3\mu}{8}\omega^2 r^2 + \frac{E}{1-\mu}C_1 + \frac{E}{1+\mu}C_2\frac{1}{r^2}$$

Using the notations

$$\frac{E}{1-\mu}C_1 = A; \quad \frac{E}{1+\mu}C_2 = B$$

$$\frac{\gamma}{g}\frac{3+\mu}{8}\omega^2 = K_R \quad \ldots\ldots\ldots\ldots (3)$$

$$\frac{\gamma}{g}\frac{1+3\mu}{8}\omega^2 = K_T \quad \ldots\ldots\ldots\ldots (4)$$

Equations 1 and 2 become

$$R = A - \frac{B}{r^2} - K_R r^2$$

$$T = A + \frac{B}{r^2} - K_T r^2$$

Substituting $1/x$ for r^2, Equations 1 and 2 take the final shape used for this discussion:*

$$R = A - Bx - \frac{K_R}{x} \quad \ldots\ldots\ldots\ldots (5)$$

$$T = A + Bx - \frac{K_T}{x} \quad \ldots\ldots\ldots\ldots (6)$$

---

* R. Grammel used these equations, with slightly different notations, in developing his graphical method. *Dinglers Polytechnical Journal*, Vol. 338, Page 217.

It is seen that in both equations only K_R and K_T depend on the angular velocity ω, whereas A and B are independent of it. This relation proves very useful for the graphical solution of the problem. Accordingly, R and T are divided into two components:

$$R = R_1 - R_2$$

where $R_1 = A - Bx$ and $R_2 = K_R/x$.

$$T = T_1 - T_2$$

where $T_1 = A + Bx$ and $T_2 = K_T/x$. Using rectangular co-ordinates, R_1 and T_1 are straight lines with slopes $-B$ and $+B$ respectively and with A as intercept on the ordinate axis. R_2 and T_2 are equilateral hyperbolas. This is illustrated in *Fig.* 1 and *Fig.* 2.

It is important to note that the intercept A is the same for the straight lines R_1 and T_1, and furthermore, that the slope is different in sign only ($-B$ and $+B$); x must always be positive since it is the reciprocal of a square. If both diagrams are put together while inverting the positive direction of the x-axis for the radial stresses, the diagram shown in *Fig.* 3 is obtained.

To illustrate the practical value of this presentation, a ring of uniform thickness which rotates about its axis at angular velocity ω will be analyzed. The material (which is supposed to be homogeneous) is known and so are the inside and outside radii r_i and r_o respectively. The following procedure is used to develop the stress diagram, *Fig.* 4:

At both sides of the origin of the co-ordinate system the distances $x_o = 1/r_o^2$ and $x_i = 1/r_i^2$ are marked as abscissas. To plot the hyperbolas $R_2 = K_R/x$ and $T_2 = K_T/x$, K_R and K_T are found from Equations 3 and 4. Then the ordinates pertaining to x_o and x_i are calculated:

$$R_{2o} = \frac{K_R}{x_o};\ R_{2i} = \frac{K_R}{x_i};\ T_{2o} = \frac{K_T}{x_o};\ T_{2i} = \frac{K_T}{x_i}$$

It is not necessary actually to draw the hyperbolas if only the limiting stresses are required. If, however, a complete picture of the stress distribution is desired the hyperbolas may be traced by using the well known method shown in *Fig.* 5.

Finally the straight line representing R_1 to the left side and T_1 to the right side of the ordinate axis has to be located.

From the derivation of the constants A and B it is seen that they are closely related to the constants of integration C_1 and C_2 in Equations 1 and 2. Consequently they are determined in such a way as to satisfy the conditions at the edges of the disk.

In the present problem there are obviously no radial stresses on the inner and outer edges of the ring (R_i and $R_o = 0$). These two conditions locate the straight line $R_1\ T_1$. It passes through the points determined by x_i, R_{2i} and x_o, R_{2o}.

The shaded areas between the straight line and the hyperbolas extending from x_o to x_i represent the radial stresses at the left side, and the tangential stresses at the right side of the ordinate axis. The areas are positive and, therefore, all stresses are tensile.

In practice, however, the thickness of the disk often is not constant and sometimes the profile is not symmetrical about a plane perpendicular to the axis. In the latter case the actual profile must be approximated by another one which is symmetrical about

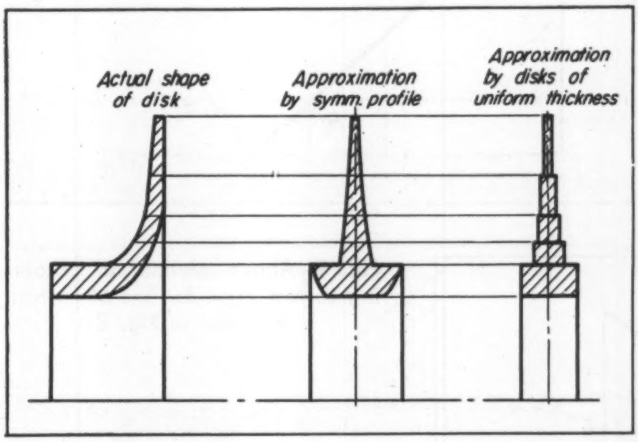

Actual shape of disk
Approximation by symm. profile
Approximation by disks of uniform thickness

Fig. 6—Above — Approximation of disk profile using a number of disks of uniform thickness

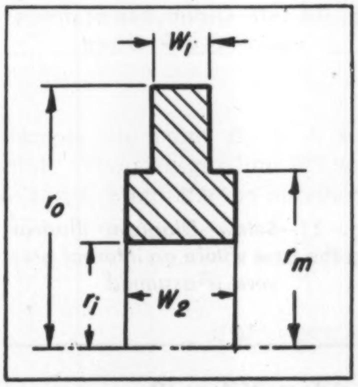


Fig. 7 — Above — Dimensions of step in radial disk used in approximating disk with unsymmetrical profile

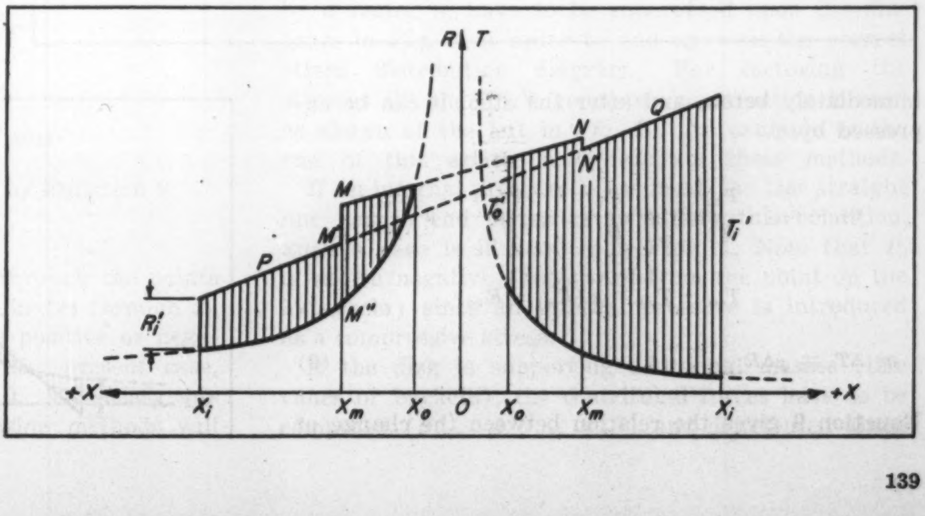


Fig. 8—Right—Stress diagram for stepped disk in Fig. 7, developed from Equations 7 and 9

such a plane. The symmetrical profile can be replaced by a number of disks of uniform thickness following closely the given contour. This is illustrated in *Fig.* 6.

How the method for a disk of uniform thickness can be extended to a stepped disk (a combination of disks of uniform thickness) will now be discussed. The disk in *Fig.* 7 changes its width from w_1 to w_2 at a distance r_m from the axis of rotation. The first observation is that the transmitted radial force immediately before and after the step must be the same. If the radial stresses at these locations are R_{m1} and R_{m2}, respectively, then $R_{m1} \times 2\pi\ r_m\ W_1 = R_{m2} \times 2\ \pi r_m\ W_2$ or

$$\frac{R_{m1}}{R_{m2}} = \frac{W_2}{W_1} \qquad (7)$$

Equation 7 states that the radial stresses change inversely as the widths. To determine the change in tangential stresses at the step, application of the following reasoning will yield a method of procedure:

Deformation of an element subject to two stresses perpendicular to each other is expressed by the equation:

$$e_t = \frac{T}{E} - \mu\frac{R}{E} \qquad (8)$$

where e_T denotes the unit elongation in direction of *T*.

Since the circumferential elongations are the same immediately before and after the step, it can be expressed by

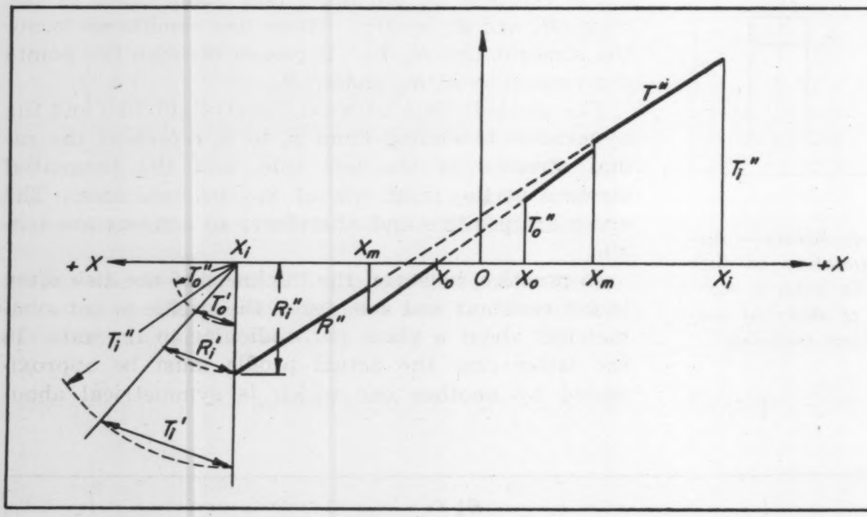


Fig. 10—Left—Distribution of stresses assuming disk at rest

$$e_{T1} = e_{T2};\ \frac{T_{m1}}{E} - \mu\frac{R_{m1}}{E} = \frac{T_{m2}}{E} - \mu\frac{R_{m2}}{E}$$

$$T_{m1} - T_{m2} = \mu\ (R_{m1} - R_{m2})$$

$$\text{or } \Delta T = \mu\Delta R \qquad (9)$$

Equation 9 gives the relation between the change of radial and tangential stresses at the step. Here the simple rule is found that the change in tangential stress is equal to the change in radial stress times Poisson's ratio.

With the aid of Equations 7 and 9 the stress diagram for the stepped disk in *Fig.* 7 develops as follows, (*Fig.* 8):

Hyperbolas $R_2 = K_R/x$ and $T_2 = K_T/x$ are independent of the width and are obtained as outlined before. Radial stresses on the inner and outer edges are again assumed to be zero ($R_o = 0$ and $R_i = 0$). The radial stress at the step will change according to Equation 7 and the tangential stress will be found from Equation 9.

Starting from either of the two points for which the conditions are known ($R_o = 0$ and $R_i = 0$), a straight line is drawn arbitrarily; in the present

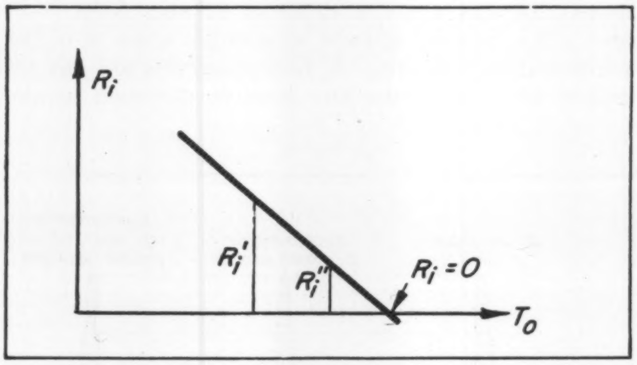


Fig. 9—Above—Method of obtaining correct slope for line MN which is shown in Fig. 8

Fig. 11—Below—Diagram illustrating the case where an internal pressure is assumed

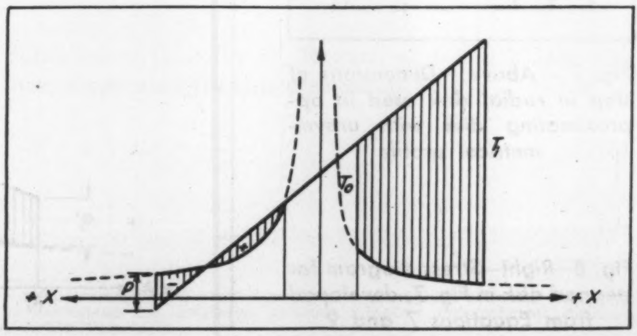


Fig. 12—Right—Stresses in a disk having a small bore

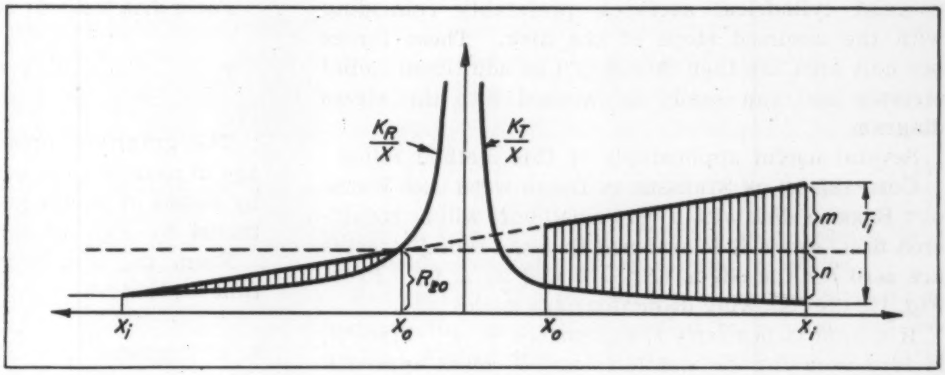


Fig. 13 — Below — Graphical stress presentation for a disk of uniform thickness, simple geometric relations of which are useful in deriving formulas

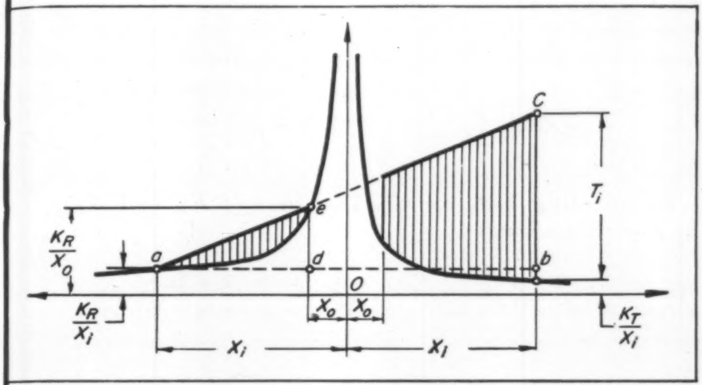
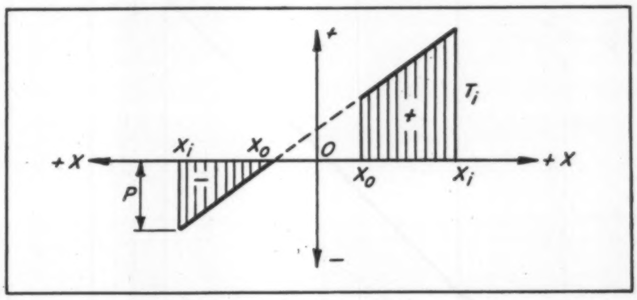


Fig. 14—Below—Stresses in a stationary cylinder with internal pressure. Hyperbolas degenerate into straight lines coinciding with the axes



example the point $R_o = 0$ was chosen as starting point. The straight line MN is assumed first. At $x_m = 1/r_m^2$, jump MM' is obtained from Equation 8:

$$\frac{R_{m1}}{R_{m2}} = \frac{W_2}{W_1} = \frac{MM''}{M'M''}$$

$$M'M'' = MM''\frac{W_1}{W_2}$$

$$\Delta R = MM' = MM'' - M'M''$$

In the T plane the jump is given by Equation 9;

$$\Delta T = NN' = \mu MM'$$

Next a straight line PQ is drawn through the points M' and N' and extended to the ordinates through x_i. It is probable that this will give a positive or negative value for R_i ($R_i \neq 0$). In the present case, however, it is required that $R_i' = 0$. To satisfy this condition, either of the two following methods will yield the correct answer:

1. A second trial has to be made by changing the slope of MN. The result will be another value of R_i ($R_i'' \neq 0$). With these values for R_i' and R_i'' a diagram is plotted, *Fig.* 9, which will give the correct slope for MN, i.e., the slope that will end up with $R_i = 0$. In this diagram the assumed stresses T_o are plotted as abscissas and the R_i values are plotted as ordinates. Then a straight line is drawn through the points determined by R_i' and R_i''. Where this line intersects the abscissa, $R_i = 0$; the final value of T_o is found as the length of the intercept on the abscissa.

2. Another method of procedure is obtained by the following reasoning: The diagram in *Fig.* 8 may be considered as being composed of two parts. The first part represents the stresses caused by the centrifugal forces acting on the mass particles of the disk. The second part is caused by the forces acting on the inner surface of the disk and these forces produce a stress distribution which is independent of the rotational speed. By superposing the latter distribution upon the original diagram a stress R_i will be obtained so as to satisfy the free surface condition.

To determine such a distribution of stresses, the simplest method is to assume the disk at rest, since for this particular case the hyperbolas K_R/x and K_T/x degenerate into straight lines coinciding with the axes, *Fig.* 10. An arbitrary line is drawn through X_o and $R_o = 0$. At X_m the step is obtained as outlined before and finally R_i'' is obtained. The required stress R_i is determined by the relation

$$R_i = R_i' + nR_i''$$

This means that the stresses in *Fig.* 10, multiplied by a factor *n*, have to be superposed upon the diagram in *Fig.* 8 in order to end up with the correct stress distribution diagram. For factoring the stresses R'' and T'', a geometric construction is used as shown at the left in *Fig.* 10. An example at the end of this article will illustrate these methods.

If an internal pressure is assumed, the last straight line has to end up so as to satisfy this condition. Such a case is illustrated in *Fig.* 11. Note that P_i is shown negative (downward from the point on the hyperbola) since an internal pressure is introduced as a compressive stress.

If the disk is supporting additional masses (like vanes or buckets), the centrifugal forces have to be computed ($F = w/g \times r_o\omega^2$) and distributed along co-axial cylindrical surfaces, preferably coinciding with the assumed steps of the disk. These forces per unit area are then introduced as additional radial stresses and can easily be worked into the stress diagram.

Several useful applications of this method follow:

COMPARISON OF STRESSES IN DISKS WITH AND WITHOUT BORE. A disk with a very small bore will be considered first. Again it is assumed that the radial stresses are zero for the edges ($R_o = 0$ and $R_i = 0$). From *Fig.* 12, the following deductions are made:

If r_i approaches zero, x_i approaches $+\infty$. Since R_i is zero even for the smallest bore, T_i must approach the value $2 \times R_{2o}$; this conclusion is derived by considering that as x_i approaches $+\infty$, m and n approach the value R_{2o}.

A disk without bore is characterized by the condition that for the center $R_i = T_i$. *Fig.* 12 shows that in this case $R_i = T_i = R_{2o}$.

The algebraic formulas for T_i are developed from

$$R_{2o} = \frac{K_R}{x_o} = \frac{\gamma}{g}\,\frac{3+\mu}{8}\,\omega^2 r_o{}^2$$

If the peripheral speed $V_o = r_o\omega$ is introduced, the following expressions are obtained:

For a disk with a small bore

$$T_i = \frac{\gamma}{g}\,\frac{3+\mu}{4}\,V_o{}^2 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (10)$$

For a disk without bore

$$T_i = \frac{\gamma}{g}\,\frac{3+\mu}{8}\,V_o{}^2 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (11)$$

The graphical presentation also offers an advantage in assisting the designer to derive useful formulas by means of simple geometric relations. This is illustrated by *Fig.* 13 for a disk of uniform thickness.

From the similarity of triangles *abc* and *ade* it follows that

$$\frac{T_i + \dfrac{K_T}{x_i} - \dfrac{K_R}{x_i}}{2 \times {}_i} = \frac{\dfrac{K_R}{x_o} - \dfrac{K_R}{x_i}}{x_i - x_o} = \frac{K_R}{x_i xo}$$

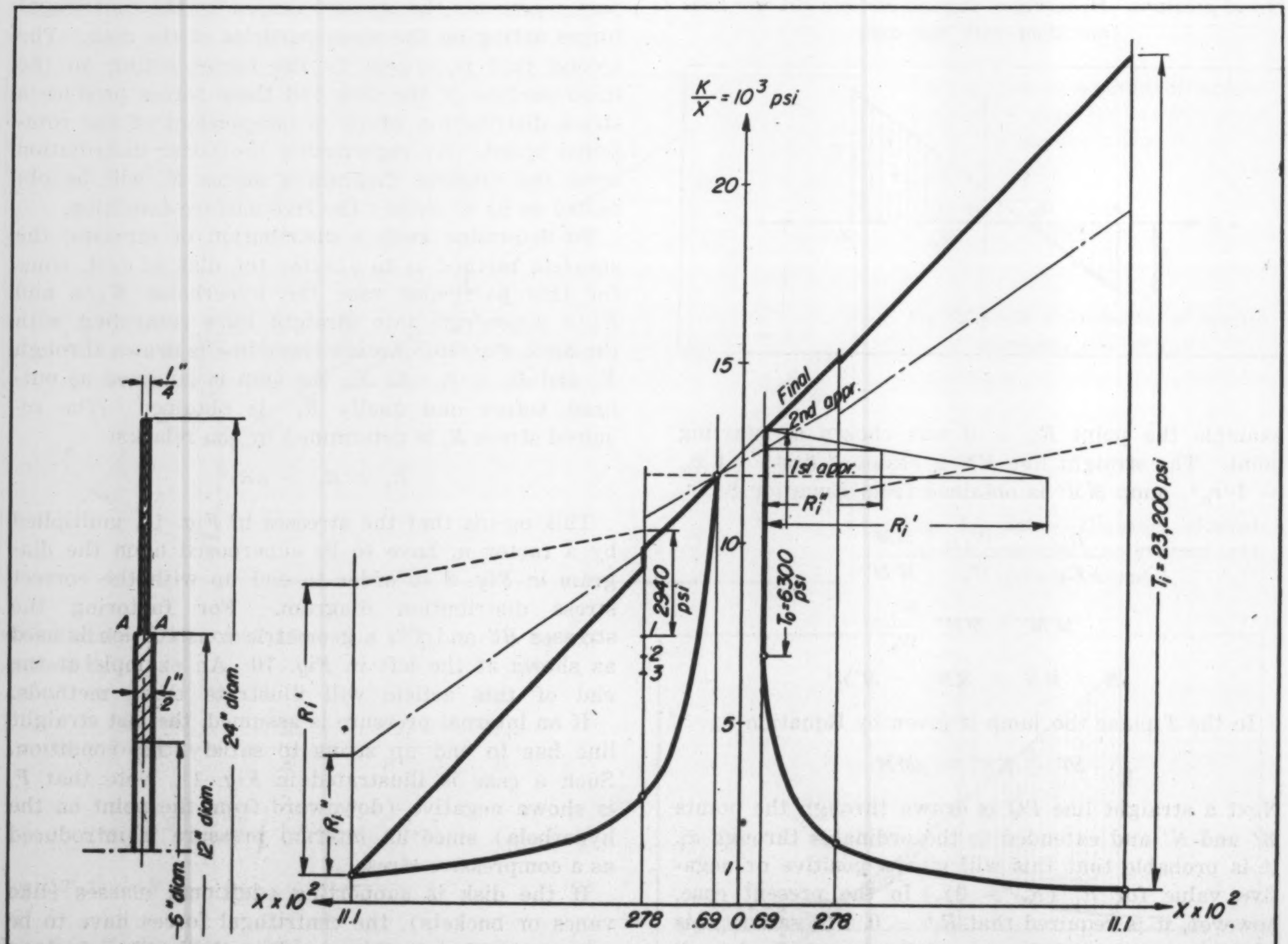
$$T_i\,x_o + K_T\frac{x_o}{xi} - K_R\frac{x_o}{x_i} = 2K_R$$

$$T_i = K_R\left(2\frac{1}{x_o} + \frac{1}{x_i}\right) - K_T\frac{1}{x_i}$$

Substituting $1/x_o$ by $r_o{}^2$, $1/x_i$ by $r_i{}^2$; K_R and K_T by Equations 3 and 4

$$T_i = \frac{\gamma}{g}\,\frac{3+\mu}{8}\,\omega^2\left(2r_o{}^2 + r_i{}^2\right) - \frac{\gamma}{g}\,\frac{1+3\mu}{8}\,\omega^2 r_i{}^2$$

Fig. 15—Graphical method for determining centrifugal stresses in a 13-vane disk rotating at 5000 rpm



$$= \frac{\gamma}{g} \frac{3+\mu}{8} \omega^2 \left[2r_o^2 + \frac{2r_i^2 - 2\mu r_i^2}{3+\mu} \right]$$

$$T_i = \frac{\gamma}{g} \frac{3+\mu}{4} V_o^2 \left[1 + \frac{1-\mu}{3+\mu} \left(\frac{r_i}{r_o} \right)^2 \right] \quad \ldots (12)$$

If $r_i = r_o$ Equation 12 reduces to the formula for a thin rotating ring,

$$T_i = \frac{\gamma}{g} V_o^2 \quad \ldots\ldots\ldots\ldots\ldots\ldots (13)$$

Derivations of the Formula for Stresses in a Cylinder with Internal Pressure. Since for this case $\omega = 0$, the hyperbolas $R_2 = K_R/x$ and $T_2 = K_T/x$ degenerate into straight lines coinciding with the axes, and the picture shown in *Fig.* 14 is obtained. The inside pressure p is shown downward since compressive stresses are negative.

Again similar triangles lead to the result

$$\frac{T_i}{x_i + x_o} = \frac{p}{x_i - x_o}$$

$$T_i = p \frac{x_i + x_o}{x_i - x_o} = p \frac{\dfrac{1}{r_i^2} + \dfrac{1}{r_o^2}}{\dfrac{1}{r_i^2} - \dfrac{1}{r_o^2}} .$$

$$T_i = p \frac{r_o^2 + r_i^2}{r_o^2 - r_i^2} \quad \ldots\ldots\ldots\ldots\ldots\ldots (14)$$

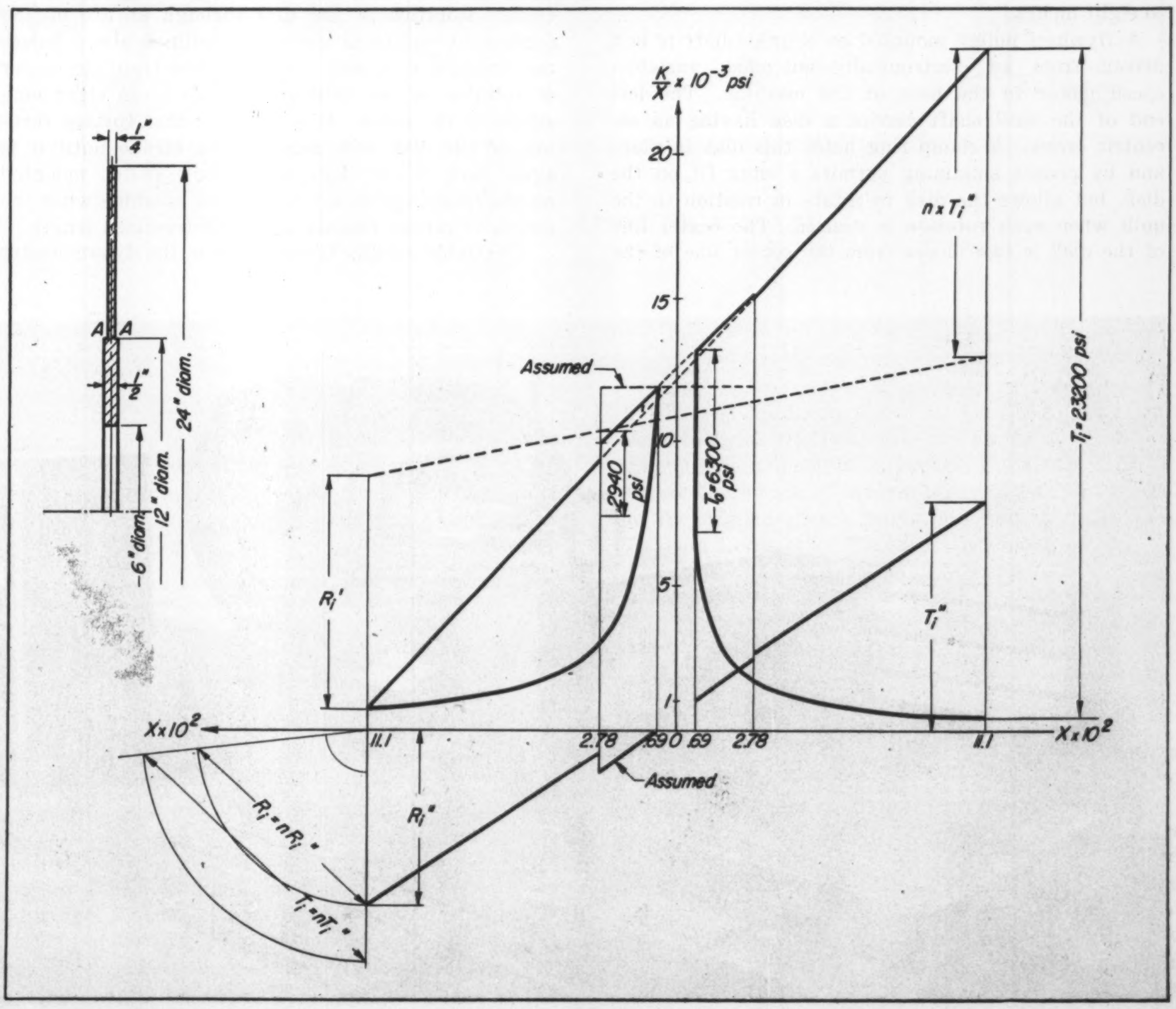
which is Lame's formula for the hoop tension in a thick-walled cylinder under internal pressure.

Examples: The following probem will serve to illustrate the method as applied to a numerical example. A steel disk, shown in *Figs.* 15 and 16, rotates at 5000 rpm. The radial stresses at the bore and rim are zero. Thirteen one-pound vanes are attached to the disk at *AA*. Assuming the center of gravity of the vanes is at a radius of 6 in., determine the radial and tangential stresses throughout the disk.

Calculations yield the following results: $\omega = 5000\pi/30 = 523$; $\gamma = 0.283$; $g = 386$; $\mu = 0.3$. Then $\omega^2 = 27.4 \times 10^4$; K_R (from Equation 3) $= 82.7$; and K_T (from Equation 4) $= 47.6$.

Centrifugal force due to the mass of the vanes is $F = M r_c \omega^2 = 55{,}300$ lb, distributed along cylinder *AA*, and $p = F/\pi DW = 2940$ psi.

Fig. 16—Diagram showing method of superposition for centrifugal stresses in a 13-vane disk rotating at 5000 rpm



DESIGNS OF THE

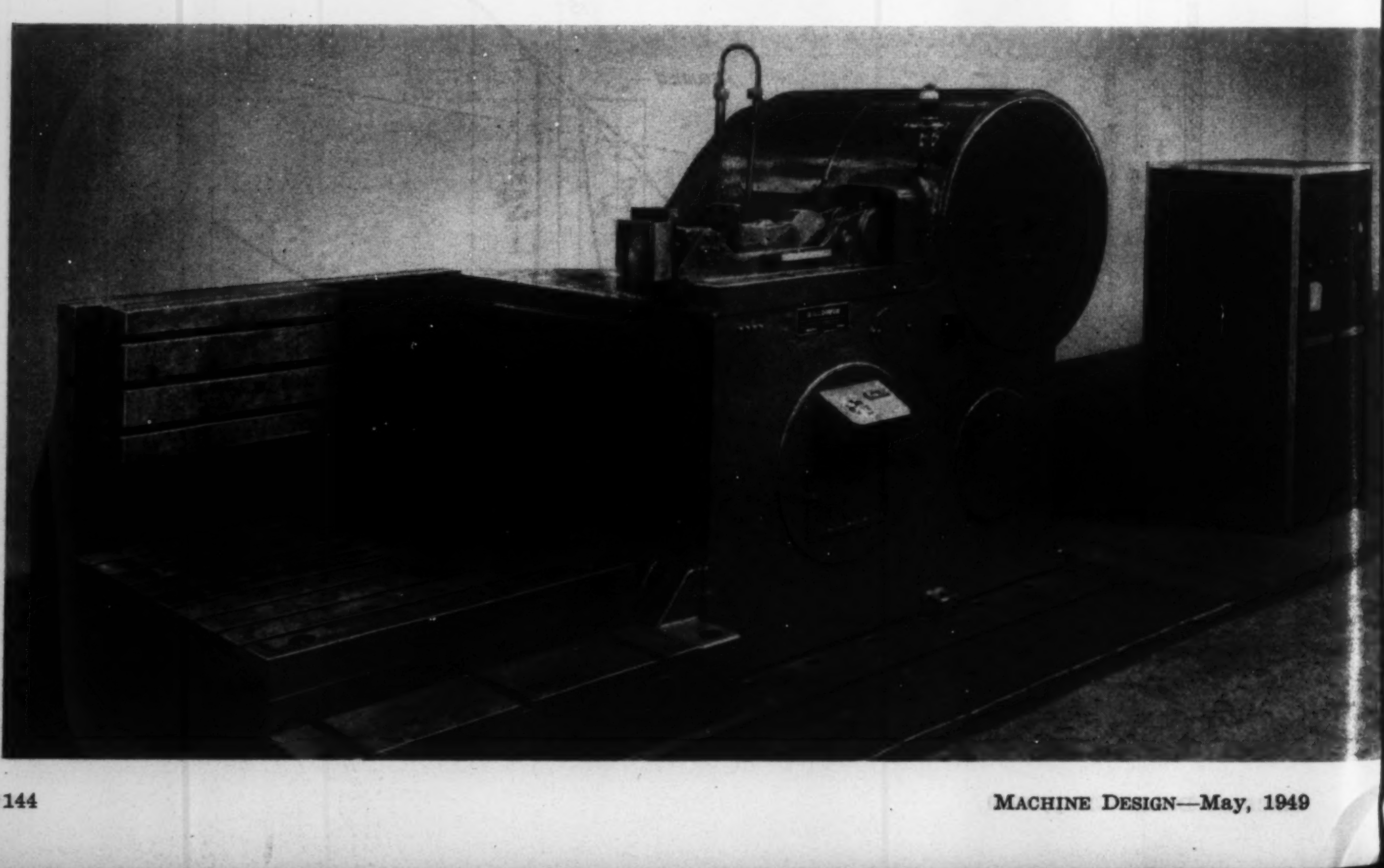
Variable Stroke Fatigue Mechanism

PLANETARY gearing in the fatigue testing machine shown in the photograph below is used to automatically vary the length of crank stroke and thereby maintain a constant load on the specimen being tested. Designed for fatigue study of full-sized machines and structural parts normally subjected to low frequency vibrations or stress variations, the machine is capable of loading a part 5 by 5 by 5 feet to 10,000 pounds in tension or compression at 250 cycles per minute. The drawing, next page, illustrates the method whereby the stroke can be varied from zero to eight inches.

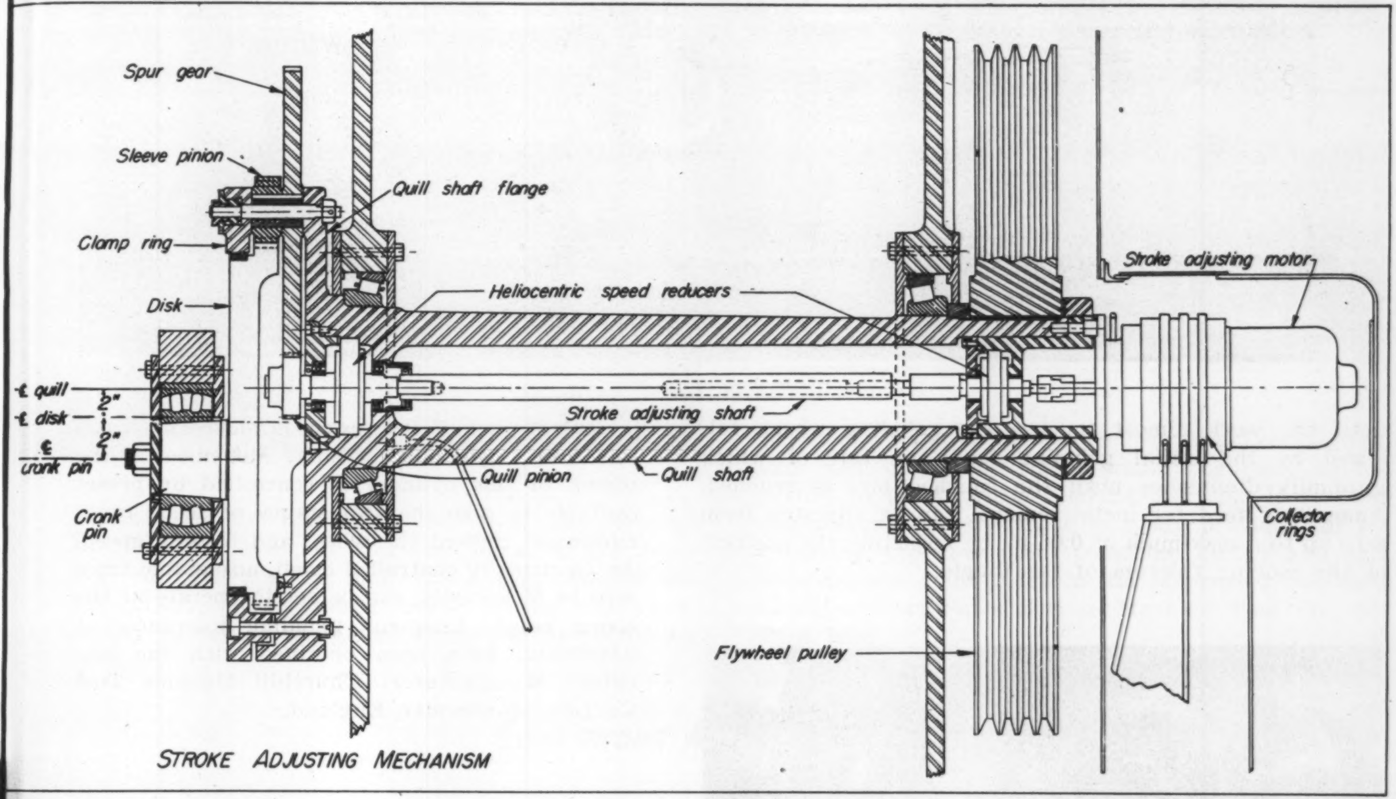
A flywheel pulley mounted on a quill shaft is belt driven from an electronically-controlled, variable-speed motor in the base of the machine. The left end of the quill shaft carries a disk having an eccentric crank. A clamp ring holds this disk in place and by proper shimming permits a snug fit on the disk, but allows the disk to rotate in relation to the quill when such rotation is desired. The center line of the disk is two inches from the center line of the quill shaft, and the center of the eccentric crankpin is two inches removed from the center of the disk. Gear teeth on the outer diameter of the disk mesh with a sleeve pinion which is keyed to and rotated by a spur gear. This gear in turn meshes with a quill pinion and the drive continues back through two Heliocentric speed reducers to the stroke adjusting motor, mounted on and rotating with the quill shaft. Current for the stroke adjusting motor is transmitted through collector rings mounted on the outside of the motor frame.

From the drawing it can be seen that it is possible for the disk to be rotated to a position such that the center lines of the quill shaft and crankpin coincide. In this position there would be no movement of the crank. Rotation of the disk through an arc of 180 degrees by means of the drive outlined above moves the crankpin to a position four inches from the center of rotation of the quill and results in an eight inch stroke of the crank. It is apparent that further turning of the disk will decrease the stroke until it is again zero at 360 degrees. A limit switch mounted on the frame can be set to stop the machine when the length of stroke reaches any predetermined length.

A variable air-gap transformer in the dynamometer



MONTH


Spur gear
Sleeve pinion
Quill shaft flange
Clamp ring
Heliocentric speed reducers
Disk
℄ quill
2"
℄ disk
2"
℄ crank pin
Stroke adjusting shaft
Crank pin
Quill pinion
Quill shaft
Stroke adjusting motor
Collector rings
Flywheel pulley

STROKE ADJUSTING MECHANISM

causes the current to a galvanometer mirror to vary in proportion to the load. Reflection of a luminous spot from a mirror onto a graduated scale on the control panel indicates the load. Control of the load is by means of a light sensitive cell aimed at the end position reached by the luminous spot on the scale. If the test specimen starts to weaken and the spot fails to reach the light cell, the motor of the stroke change mechanism is automatically actuated to increase the length of stroke until the load is restored to its original preset magnitude. Manufacturer: The Baldwin Locomotive Works, Philadelphia.

Grinder Tilting Table Feed

An unusual change in the automatic plain grinding machine shown, top, next page, resulted in the discontinuance of the long established method of feeding the grinding wheel by moving the wheelhead into the workpiece. In this machine, the wheelhead is set at the required position and not moved again during a production run. Feed is applied by tilting the table, which carries workhead, tailstock and workpiece (shown in the closeup photograph bottom, next page) toward the wheel. The object of this new system is to overcome the uncertainty of movement in a heavy wheelslide where position must be repeated within a few hundred thousandths of an inch.

The work carrying table is mounted on knife edges at the inner edge, the front of the table being lifted by a simple toggle movement which has the advantage of giving a rapid initial feed. Speed of feed is automatically reduced as the toggle is brought closer to the in-line position. Forward tilting movement is automatically divided into two stages: A quick lift

Churchill
THE Churchill
MACHINE TOOL Co LTD
MANCHESTER ENGLAND

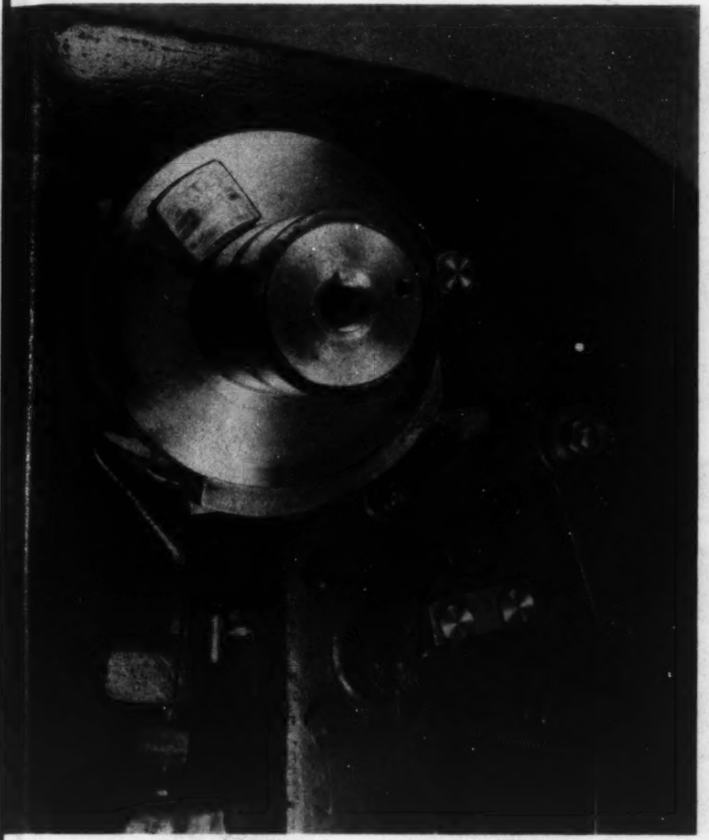
until the work almost touches the grinding wheel, followed by the initial grinding feed, the rate of which gradually diminishes until the finished size is reached. Amount of feed for metal removal can be adjusted from zero up to a maximum of 0.06-in. by adjusting the position of the moving fulcrum of the toggle.

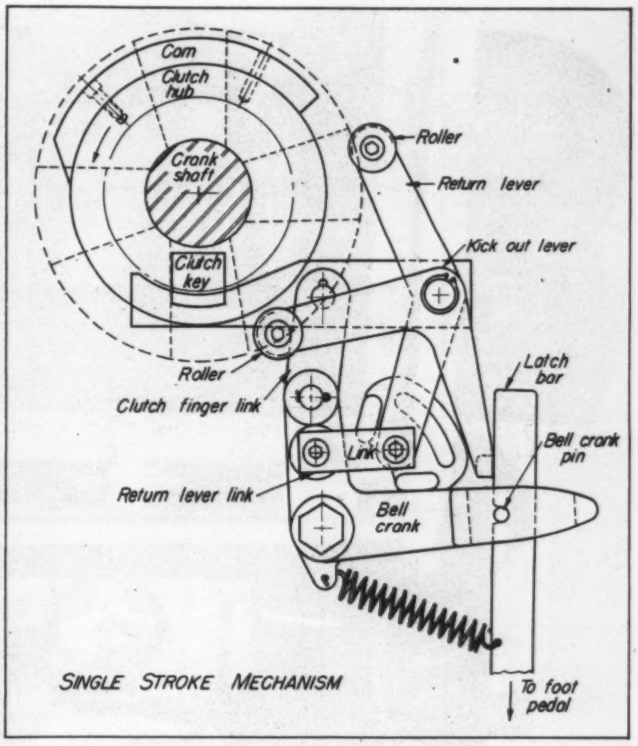
Center pivot of the toggle is moved by a rod linked to a hydraulic cylinder. Movement of the piston in this cylinder is controlled by preset contacts to give the two stages of feed; rapid movement toward the wheel and feeding speed. An electrically controlled dwell, adjustable from zero to 60 seconds, can be set to operate at the sizing point. Long-run grinding tolerances of 0.00003-in. have been obtained with the machine. Manufacturer: Churchill Machine Tool Co. Ltd., Manchester, England.

Fulcro-Sizer

Single-Stroke Clutch Control

DESIGNED for single-stroke operation of presses, the mechanism shown with flywheel removed in the photograph provides a simple, positive control requiring no adjustment. Depressing the foot pedal which is connected to a latch bar (see drawing next page) allows a bell crank to move the clutch finger away from the clutch key. This conventional sliding clutch key engages the flywheel (not shown) and rotates the crankshaft with the flywheel for about ¼ revolution. A cam attached to and rotating with the clutch hub then contacts the kick-out lever roller, causing the latch bar to disengage from the bell crank pin and allowing the clutch finger to return to its original position. The clutch finger then retracts the clutch key, permitting the flywheel to rotate freely regardless of how long the operator keeps the foot pedal depressed. Another stroke of the press cannot be started until the operator



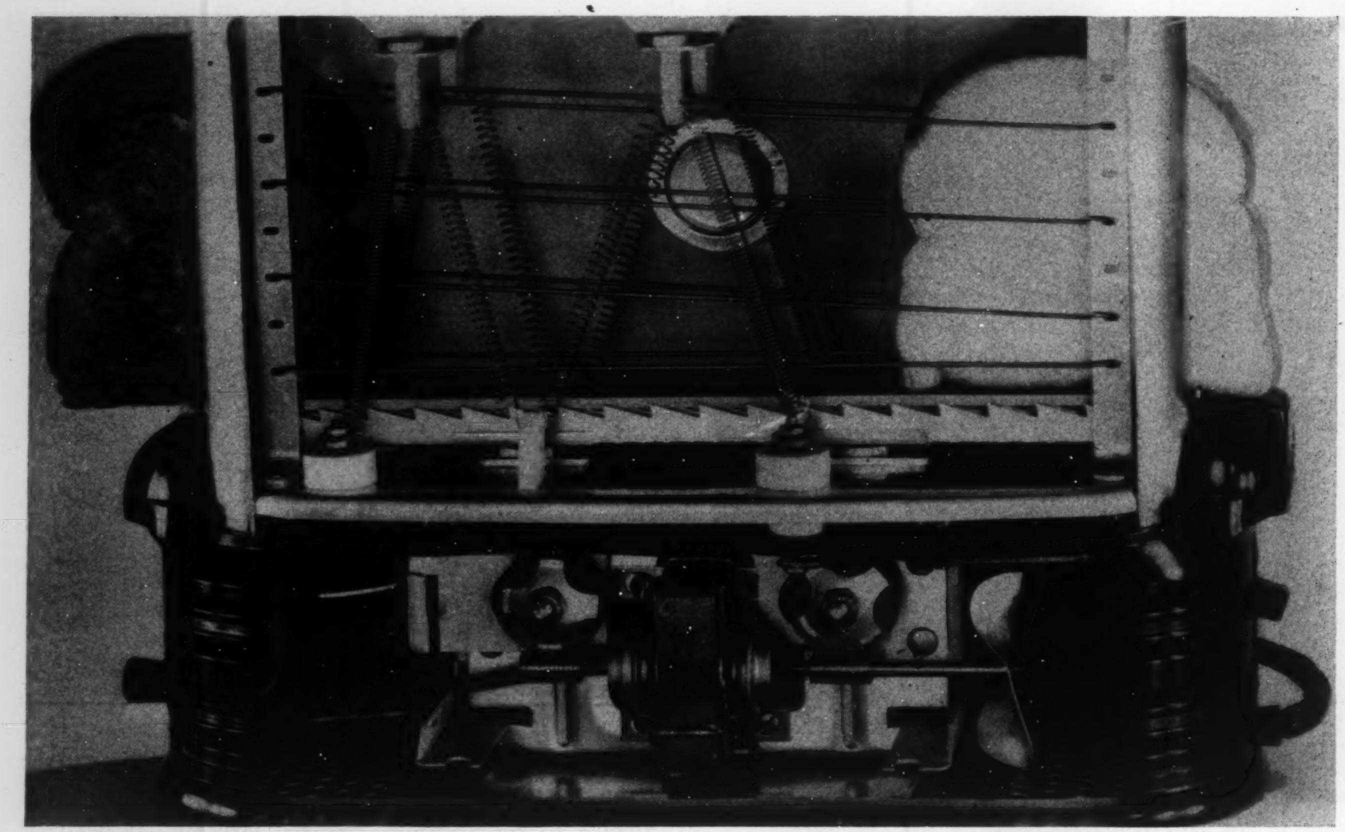

Cam
Clutch hub
Crank shaft
Clutch key
Roller
Return lever
Kick out lever
Roller
Clutch finger link
Latch bar
Link
Bell crank pin
Return lever link
Bell crank
SINGLE STROKE MECHANISM
To foot pedal

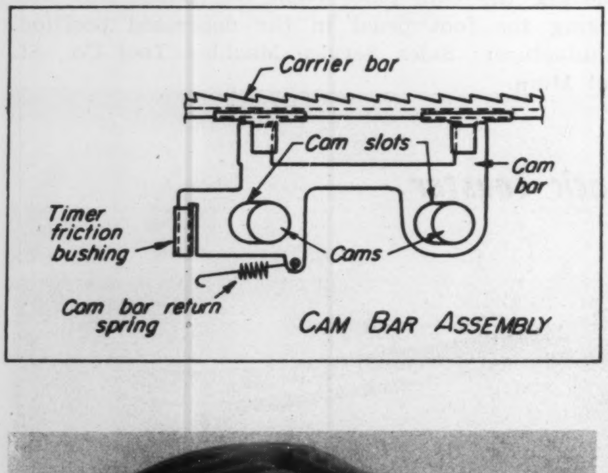
releases the foot pedal, the latch bar has returned to its upper position and the notch in the latch bar has engaged the bell crank pin. Should the bell crank return spring break during the cycle, failing to return the clutch finger to the retracting position, a roller on the return lever would contact the cam and the clutch finger would positively be returned to the flywheel released position. If desired, continuous press operation is easily provided for by removing the cam plate from the clutch hub and hooking the foot pedal in the depressed position. Manufacturer: Sales Service Machine Tool Co., St. Paul, Minn.

Continuous Automatic Toaster

BREAD slices fed vertically into a slot at one end of the toaster shown in the photograph, right, are moved up and down and forward between heating elements at a predetermined rate and are delivered fully toasted within a minute at the opposite end. The reciprocating action of the notched toast conveyor or carrier bar is accomplished with a novel yet simple cam drive.

As is readily seen in the partially disassembled horsepower motor drives two worm gears through worms mounted on the motor shaft. Cams mounted on the worm gear shafts turn in slots in a cam bar which carries the notched carrier bar, drawing next page. A coil spring tends to pull this cam bar to the left. Orbital motion of the carrier bar is accomplished by the cams moving the cam bar to the right and the coil spring pulling the cam bar back to the left. Toast is moved through the toaster by the teeth on the carrier bar engaging the bottom of the bread only on the upper half of the circulatory motion, moving it to the left





CAM BAR ASSEMBLY

through the toaster. On the lower half of the carrier bar cycle, the teeth drop below the track on which the bread rides, leaving it on the support bar until the upper half of the next cycle.

Adjustment for degree of darkness of the toast is made by moving a timer lever, thereby varying the location of the stop against which the cam bar is drawn by the tension spring. When the cam bar is thus held back, the horizontal travel of the carrier bar is decreased, shortening the stroke, which increases the travel time of the toast and makes it darker. A small fan mounted on the motor shaft provides ventilation for the motor and the insulated base protects table tops. Manufacturer: Toast-O-Lator Co. Inc., Long Island City, N. Y.

Clean-Lined Compressor

USE of functional cooling fins to enhance the appearance of this portable, electric air compressor has resulted in a well-designed, clean-cut unit. Heart of the compressor is a special synthetic diaphragm, which, combined with stainless steel, reed type valves and sealed ball bearing construction throughout, results in quiet, long-life operation. Plugging into an ordinary 110 volt, a-c light socket or wall plug provides 2½ cfm of filtered air at 35 psi for painting or any other application requiring compressed air. Manufacturer: Devilbiss Co., Toledo, Ohio.

Helical Gears to Replace Spur Gears

By Carl A. Johnson
Perkins Machine & Gear Co.
Springfield, Mass.

WHEN redesigning machinery and appliances it is often desirable to replace spur gears with helical gears. One method of accomplishing this, where no change in ratio is allowed, involves the use of hobs of a finer pitch (MACHINE DESIGN, July, 1947, Page 155). Since finer pitch hobs may not be available or finer pitch gears may not be desirable the accompanying tables list the total number of teeth and helix angle for a pair of helical gears to replace a pair of spur gears of the same pitch and any total number of teeth from 30 to 107.

Basis of the tables is as follows: For the spur gear, $D_s = N_s/P_d$, and for the helical gear $D_h = N_h/P_{nd}\cos\alpha$, where D_s and D_h denote the spur gear and helical gear pitch diameters, respectively; N_s and N_h denote the number of teeth in the spur and helical gears; P_d is the diametral pitch of the spur gears; P_{nd} is the normal diametral pitch of the helical gears; and α is the helix angle.

To allow helical gears to operate at the same center distance as spurs, $D_s = D_h$, therefore

$$\frac{N_s}{P_d} = \frac{N_h}{P_{nd}\cos\alpha}$$

Inasmuch as $P_d = P_{nd}$ this equation becomes

$$\cos\alpha = \frac{N_h}{N_s}$$

Often an approximation to the desired ratio may have to be used. The following example illustrates the use of the tables: A pair of spur gears with 15 and 65 teeth is to be replaced by helical gears. The total number of teeth in the pair is 15 + 65 = 80 and the ratio is 65/15 = 4.333. Using 14 and 61 teeth, a total of 75, the helix angle is 20° 21′ 51″ and the ratio 4.357. If a larger helix angle is desired use 13 and 56 teeth, a total of 69, which gives a helix angle of 30° 24′ 6″ and a ratio of 4.308. The exact ratio of 4.333 can be obtained with a 36° 51′ 12″ helix angle using 12 and 52 teeth, a total of 64.

Total Teeth in Spur Gears	Total Number of Teeth and Helix Angle of Pair of Helical Gears to Replace Spur Gears at Same Center Distance											
30	29 14°50′6″	28 21°2′22″	27 25°50′31″	26 29°55′35″	25 33°33′26″	24 36°52′12″	23 39°56′40″	22 42°50′0″				
31	30 14°35′33″	29 20°45′41″	28 25°24′53″	27 29°25′43″	26 32°59′45″	25 36°14′58″	24 39°16′5″	23 42°6′12″	22 44°47′29″			
32	31 14°21′41″	30 20°21′51″	29 25°0′28″	28 28°57′18″	27 32°27′42″	26 35°39′33″	25 38°37′29″	24 41°24′35″	23 44°2′55″			
33	32 14°8′28″	31 20°3′0″	30 24°37′12″	29 28°30′13″	28 31°57′10″	27 35°5′49″	26 38°0′44″	25 40°44′57″	24 43°20′30″			
34	33 13°55′50″	32 19°45′0″	31 24°14′59″	30 28°4′21″	29 31°28′1″	28 34°33′37″	27 37°25′41″	26 40°7′9″	25 42°40′4″			
35	34 13°43′45″	33 19°27′47″	32 23°53′44″	31 27°39′38″	30 31°0′10″	29 34°2′52″	28 36°52′12″	27 39°31′4″	26 42°1′29″	25 44°24′55″		
36	35 13°32′10″	34 19°11′17″	33 23°33′23″	32 27°15′58″	31 30°33′30″	30 33°33′26″	29 36°20′10″	28 38°56′33″	27 41°24′35″	26 43°45′42″		
37	36 13°21′4″	35 18°55′29″	34 23°13′53″	33 26°53′17″	32 30°7′58″	31 33°5′15″	30 35°49′29″	29 38°23′30″	28 40°49′15″	27 43°8′11″		
38	37 13°10′25″	36 18°40′18″	35 22°55′10″	34 26°31′31″	33 29°43′28″	32 32°38′13″	31 35°20′4″	30 37°51′49″	29 40°15′24″	28 42°32′13″	27 44°43′20″	
39	38 13°0′10″	37 18°25′43″	36 22°37′12″	35 26°10′37″	34 29°19′56″	33 32°12′15″	32 34°51′50″	31 37°21′25″	30 39°42′54″	29 41°57′43″	28 44°6′53″	
40	39 12°50′19″	38 18°11′42″	37 22°19′54″	36 25°50′31″	35 28°57′18″	34 31°47′18″	33 34°24′41″	32 36°52′12″	31 39°11′42″	30 41°24′35″	29 43°31′52″	
41	40 12°40′49″	39 17°58′11″	38 22°3′15″	37 25°31′10″	36 28°35′32″	35 31°23′17″	34 33°58′35″	33 36°24′5″	32 38°41′41″	31 40°52′43″	30 42°58′13″	29 44°58′59″
42	41 12°31′40″	40 17°45′10″	39 21°47′12″	38 25°12′32″	37 28°14′33″	36 31°0′10″	35 33°33′26″	34 35°57′2″	33 38°12′48″	32 40°22′3″	31 42°25′50″	30 44°24′55″
43	42 12°22′51″	41 17°32′37″	40 21°31′44″	39 24°54′33″	38 27°54′20″	37 30°37′52″	36 38°9′12″	35 35°30′58″	34 37°44′57″	33 39°52′31″	32 41°54′39″	31 43°52′7″
44	43 12°14′20″	42 17°20′29″	41 21°16′48″	40 24°37′12″	39 27°34′49″	38 30°16′22″	37 32°45′50″	36 35°5′48″	35 37°18′6″	34 39°24′2″	33 41°24′35″	32 43°20′30″

Total Teeth in Spur Gears	Total Number of Teeth and Helix Angle of Pair of Helical Gears to Replace Spur Gears at Same Center Distance																		
45	44 12°6′5″	43 17°8′46″	42 21°2′22″	41 24°20′26″	40 27°15′58″	39 29°55′35″	38 32°23′15″	37 34°41′32″	36 36°52′12″	35 38°56′33″	34 40°55′34″	33 42°50′0″	32 44°40′29″						
46	45 11°58′7″	44 16°57′27″	43 20°48′25″	42 24°4′14″	41 26°57′45″	40 29°35′31″	39 32°1′26″	38 34°18′4″	37 36°27′10″	36 38°30′0″	35 40°27′33″	34 42°20′33″	33 44°9′38″						
47	46 11°50′25″	45 16°46′29″	44 20°34′55″	43 23°48′34″	42 26°40′7″	41 29°16′6″	40 31°40′21″	39 33°55′23″	38 36°2′58″	37 38°4′20″	36 40°0′28″	35 41°52′6″	34 43°39′49″						
48	47 11°42′57″	46 16°35′52″	45 20°21′51″	44 23°33′23″	43 26°23′4″	42 28°57′18″	41 31°19′56″	40 33°33′26″	39 35°39′33″	38 37°39′30″	37 39°34′16″	36 41°24′35″	35 43°11′0″	34 44°54′2″					
49	48 11°35′43″	47 16°25′35″	46 20°9′11″	45 23°18′41″	44 26°6′32″	43 28°39′6″	42 31°0′10″	41 33°12′11″	40 35°16′53″	39 37°15′29″	38 39°8′55″	37 40°57′57″	36 42°43′7″	35 44°24′55″					
50	49 11°28′42″	48 16°15′37″	47 19°56′54″	46 23°4′26″	45 25°50′31″	44 28°21′27″	43 30°41′0″	42 32°51′36″	41 34°54′55″	40 36°52′12″	39 38°44′22″	38 40°32′9″	37 42°16′7″	36 43°56′44″					
51	50 11°21′54″	49 16°5′56″	48 19°45′0″	47 22°50′37″	46 25°34′59″	45 28°4′21″	44 30°22′26″	43 32°31′38″	42 34°33′37″	41 36°29′38″	40 38°20′34″	39 40°7′9″	38 41°49′57″	37 43°29′25″					
52	51 11°15′17″	50 15°56′32″	49 19°33′26″	48 22°37′12″	47 25°19′54″	46 27°47′45″	45 30°4′24″	44 32°12′15″	43 34°12′58″	42 36°7′44″	41 37°57′29″	40 39°42′54″	39 41°24′35″	38 43°2′57″	37 44°38′23″				
53	52 11°8′52″	51 15°47′25″	50 19°22′12″	49 22°24′10″	48 25°5′15″	47 27°31′38″	46 29°46′54″	45 31°53′27″	44 33°52′55″	43 35°46′29″	42 37°35′5″	41 39°19′23″	40 40°59′58″	39 42°37′16″	38 44°11′39″				
54	53 11°2′37″	52 15°38′33″	51 19°11′17″	50 22°11′30″	49 24°51′2″	48 27°15′58″	47 29°29′54″	46 31°35′11″	45 33°33′26″	44 35°25′51″	43 37°13′20″	42 38°56′33″	41 40°36′4″	40 42°12′20″	39 43°45′42″				
55	54 10°56′33″	53 15°29′55″	52 19°0′41″	51 21°59′11″	50 24°37′12″	49 27°0′44″	48 29°13′22″	47 31°17′26″	46 33°14′31″	45 35°5′48″	44 36°52′12″	43 38°34′22″	42 40°12′51″	41 41°48′7″	40 43°20′30″	39 44°50′20″			
56	55 10°50′39″	54 15°21′32″	53 18°50′21″	52 21°47′12″	51 24°23′45″	50 26°45′56″	49 28°57′18″	48 31°0′10″	47 32°56′7″	46 34°46′19″	45 36°31′39″	44 38°12′48″	43 39°50′17″	42 41°24′35″	41 42°56′1″	40 44°24′55″			
57	56 10°44′54″	55 15°13′22″	54 18°40′18″	53 21°35′33″	52 24°10′39″	51 26°31′31″	50 28°41′40″	49 30°43′22″	48 32°38′13″	47 34°27′21″	46 36°11′40″	45 37°51′49″	44 39°28′21″	43 41°1′42″	42 42°32′13″	41 44°0′12″			
58	57 10°39′18″	56 15°5′25″	55 18°30′31″	54 21°24′12″	53 23°57′54″	52 26°17′30″	51 28°26′27″	50 30°27′1″	49 32°20′48″	48 34°8′54″	47 35°52′13″	46 37°31′25″	45 39°7′0″	44 40°39′26″	43 42°9′3″	42 43°36′10″			
59	58 10°33′50″	57 14°57′40″	56 18°20′59″	55 21°13′19″	54 23°45′29″	53 26°3′50″	52 28°11′37″	51 30°11′6″	50 32°3′50″	49 33°50′56″	48 35°33′17″	47 37°11′33″	46 38°46′14″	45 40°17′46″	44 41°46′31″	43 43°12′47″	42 44°36′47″		
60	59 10°28′31″	58 14°50′6″	57 18°11′42″	56 21°2′22″	55 23°33′23″	54 25°50′31″	53 27°57′10″	52 29°55′35″	51 31°47′18″	50 33°33′26″	49 35°14′51″	48 36°52′12″	47 38°26′0″	46 39°56′40″	45 41°24′35″	44 42°50′0″	43 44°13′12″		
61	60 10°23′20″	59 14°42′44″	58 18°2′38″	57 20°42′10″	56 23°21′35″	55 25°37′32″	54 27°43′6″	53 29°40′28″	52 31°31′11″	51 33°16′23″	50 34°56′53″	49 36°33′20″	48 38°6′17″	47 39°36′7″	46 41°3′12″	45 42°27′49″	44 43°50′14″		
62	61 10°18′16″	60 14°35′33″	59 17°53′48″	58 20°41′37″	57 23°10′5″	56 25°24′53″	55 27°29′22″	54 29°25′43″	53 31°15′29″	52 32°59′45″	51 34°39′22″	50 36°14′58″	49 37°47′4″	48 39°16′5″	47 40°42′22″	46 42°6′12″	45 43°27′50″	44 44°47′29″	
63	62 10°13′20″	61 14°28′32″	60 17°45′10″	59 20°31′37″	58 22°58′51″	57 25°12′32″	56 27°15′58″	55 29°11′20″	54 31°0′10″	53 32°43′32″	52 34°22′17″	51 35°57′2″	50 37°28′19″	49 38°56′33″	48 40°22′3″	47 41°45′8″	46 43°6′1″	45 44°24′55″	
64	63 10°8′30″	62 14°21′41″	61 17°36′45″	60 20°21′51″	59 22°47′54″	58 25°0′28″	57 27°2′53″	56 28°57′18″	55 30°45′13″	54 32°27′42″	53 34°5′36″	52 35°39′33″	51 37°10′2″	50 38°37′29″	49 40°2′15″	48 41°24′35″	47 42°44′44″	46 44°2′55″	
65	64 10°3′48″	63 14°15′0″	62 17°28′31″	61 20°12′19″	60 22°37′12″	59 24°48′42″	58 26°50′7″	57 28°43′36″	56 30°30′37″	55 32°12′15″	54 33°49′20″	53 35°22′29″	52 36°52′12″	51 38°18′53″	50 39°42′54″	49 41°4′31″	48 42°23′58″	47 43°41′27″	46 44°57′9″
66	65 9°59′12″	64 14°8′28″	63 17°20′29″	62 20°3′0″	61 22°26′44″	60 24°37′12″	59 26°37′39″	58 28°30′13″	57 30°16′22″	56 31°57′10″	55 33°33′26″	54 35°5′48″	53 36°34′46″	52 38°0′44″	51 39°24′2″	50 40°44′57″	49 42°3′42″	48 43°20′30″	47 44°35′32″
67	66 9°54′42″	65 14°2′5″	64 17°12′38″	63 19°53′54″	62 22°16′31″	61 24°25′58″	60 26°25′28″	59 28°17′8″	58 30°2′26″	57 31°42′25″	56 33°17′55″	55 34°49′32″	54 36°17′45″	53 37°43′0″	52 39°5′36″	51 40°25′50″	50 41°43′55″	49 43°0′3″	48 44°14′26″
68	67 9°50′18″	66 13°55′50″	65 17°4′57″	64 19°45′0″	63 22°6′32″	62 24°14′59″	61 26°13′33″	60 28°4′21″	59 29°48′49″	58 31°28′1″	57 33°2′45″	56 34°33′37″	55 36°1′8″	54 37°25′41″	53 38°47′36″	52 40°7′9″	51 41°24′35″	50 42°40′5″	49 43°53′49″
69	68 9°45′59″	67 13°49′43″	66 16°57′27″	65 19°36′17″	64 21°56′46″	63 24°4′14″	62 26°1′54″	61 27°51′51″	60 29°35′31″	59 31°13′56″	58 32°47′55″	57 34°18′4″	56 35°44′53″	55 37°8′45″	54 38°30′0″	53 39°48′54″	52 41°5′41″	51 42°20′33″	50 43°33′41″
	49 44°45′12″																		

Total Teeth in Spur Gears	Total Number of Teeth and Helix Angle of Pair of Helical Gears to Replace Spur Gears at Same Center Distance																		
70	69 9°41'47"	68 13°43'45"	67 16°50'6"	66 19°27'47"	65 21°47'12"	64 23°53'44"	63 25°50'31"	62 27°39'38"	61 29°22'30"	60 31°0'10"	59 32°33'25"	58 34°9'0"	57 35°29'0"	56 36°52'12"	55 38°12'48"	54 39°31'4"	53 40°47'13"	52 42°1'29"	51 43°14'0"
	50 44°29'50"																		
71	70 9°37'39"	69 13°37'54"	68 16°42'55"	67 19°19'27"	66 21°37'51"	65 23°43'27"	64 25°39'22"	63 27°27'40"	62 29°9'46"	61 30°46'41"	60 32°19'14"	59 33°47'59"	58 35°13'27"	57 36°36'0"	56 37°55'58"	55 39°13'37"	54 40°29'10"	53 41°42'49"	52 42°54'45"
	51 44°5'6"																		
72	71 9°33'37"	70 13°32'10"	69 16°35'52"	68 19°11'17"	67 21°28'42"	66 23°33'23"	65 25°28'28"	64 27°15'58"	63 28°57'18"	62 30°33'30"	61 32°5'21"	60 33°33'26"	59 34°58'15"	58 36°20'10"	57 37°39'30"	56 38°56'33"	55 40°11'30"	54 41°24'35"	53 42°35'56"
	52 43°45'42"	51 44°54'2"																	
73	72 9°29'40"	71 13°26'34"	70 16°28'59"	69 19°3'18"	68 21°19'45"	67 23°23'32"	66 25°17'47"	65 27°4'30"	64 28°45'6"	63 30°20'36"	62 31°51'46"	61 33°19'12"	60 34°43'22"	59 36°4'40"	58 37°23'24"	57 38°39'51"	56 39°54'13"	55 41°6'43"	54 42°17'31"
	53 43°26'44"	52 44°34'31"																	
74	73 9°25'48"	72 13°21'4"	71 16°22'14"	70 18°55'29"	69 21°10'58"	68 23°13'53"	67 25°7'19"	66 26°53'17"	65 28°33'9"	64 30°7'58"	63 31°38'28"	62 33°5'15"	61 34°28'48"	60 35°49'29"	59 37°7'38"	58 38°23'30"	57 39°37'19"	56 40°49'15"	55 41°59'30"
	54 43°8'11"	53 44°15'25"																	
75	74 9°22'0"	73 13°15'41"	72 16°15'37"	71 18°47'49"	70 21°2'22"	69 23°4'26"	68 24°57'5"	67 26°42'17"	66 28°21'27"	65 29°55'35"	64 31°25'26"	63 32°51'36"	62 34°14'32"	61 35°34'38"	60 36°52'12"	59 38°7'30"	58 39°20'45"	57 40°32'9"	56 41°41'51"
	55 42°50'0"	54 43°56'44"																	
76	75 9°18'17"	74 13°10'25"	73 16°9'8"	72 18°40'18"	71 20°53'56"	70 22°55'10"	69 24°47'2"	68 26°31'31"	67 28°9'59"	66 29°43'28"	65 31°12'40"	64 32°38'13"	63 34°0'33"	62 35°20'4"	61 36°37'4"	60 37°51'49"	59 39°4'32"	58 40°15'24"	57 41°24'35"
	56 42°32'13"	55 43°38'26"	54 44°43'20"																
77	76 9°14'39"	75 13°5'14"	74 16°2'46"	73 18°32'56"	72 20°45'41"	71 22°46'6"	70 24°37'12"	69 26°20'58"	68 27°58'46"	67 29°31'35"	66 31°0'10"	65 32°25'6"	64 33°46'52"	63 35°5'48"	62 36°22'15"	61 37°36'28"	60 38°48'39"	59 39°58'59"	58 41°7'39"
	57 42°14'47"	56 43°20'30"	55 44°24'55"																
78	77 9°11'4"	76 13°0'10"	75 15°56'33"	74 18°25'43"	73 20°37'35"	72 22°37'12"	71 24°27'33"	70 26°10'37"	69 27°47'45"	68 29°19'56"	67 30°47'54"	66 32°12'15"	65 33°33'26"	64 34°51'50"	63 36°7'44"	62 37°21'25"	61 38°33'4"	60 39°42'54"	59 40°51'4"
	58 41°57'43"	57 43°2'57"	56 44°6'53"																
79	78 9°7'34"	77 12°55'12"	76 15°50'26"	75 18°18'38"	74 20°29'38"	73 22°28'28"	72 24°18'5"	71 26°0'28"	70 27°36'57"	69 29°8'30"	68 30°35'53"	67 31°59'39"	66 33°20'17"	65 34°38'8"	64 35°53'30"	63 37°6'40"	62 38°17'49"	61 39°27'9"	60 40°34'50"
	59 41°40'59"	58 42°45'44"	57 43°49'12"	56 44°51'28"															
80	79 9°4'7"	78 12°50'19"	77 15°44'26"	76 18°11'42"	75 20°21'51"	74 22°19'54"	73 24°8'49"	72 25°50'31"	71 27°26'21"	70 28°57'18"	69 30°24'6"	68 31°47'18"	67 33°7'23"	66 34°24'41"	65 35°39'33"	64 36°52'12"	63 38°2'51"	62 39°11'42"	61 40°18'54"
	60 41°24'35"	59 42°28'52"	58 43°31'52"	57 44°33'41"															
81	80 9°0'45"	79 12°45'31"	78 15°38'33"	77 18°4'53"	76 20°14'12"	75 22°11'30"	74 23°59'42"	73 25°40'45"	72 27°15'58"	71 28°46'19"	70 30°12'32"	69 31°35'11"	68 32°54'43"	67 34°11'31"	66 35°25'51"	65 36°38'0"	64 37°48'11"	63 38°56'33"	62 40°3'16"
	61 41°8'30"	60 42°12'20"	59 43°14'53"	58 44°16'15"															
82	81 8°57'26"	80 12°40'49"	79 15°32'46"	78 17°58'11"	77 20°6'42"	76 22°3'15"	75 23°50'46"	74 25°31'10"	73 27°5'46"	72 28°35'32"	71 30°1'11"	70 31°23'17"	69 32°42'18"	68 33°58'35"	67 35°12'26"	66 36°24'5"	65 37°33'47"	64 38°41'41"	63 39°47'57"
	62 40°52'43"	61 41°56'6"	60 42°58'13"	59 43°59'9"	58 44°58'59"														

ENGINEERING DATA SHEET

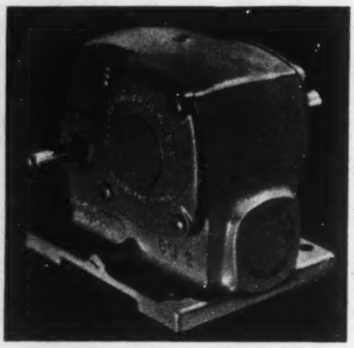
Total Teeth in Spur Gears	Total Number of Teeth and Helix Angle of Pair of Helical Gears to Replace Spur Gears at Same Center Distance																		
83	82 8°54'11"	81 12°36'12"	80 15°27'6"	79 17°51'37"	78 19°59'20"	77 21°55'9"	76 23°42'0"	75 25°21'46"	74 26°56'13"	73 28°24'57"	72 29°50'3"	71 31°11'37"	70 32°30'7"	69 33°45'54"	68 34°59'15"	67 36°10'26"	66 37°19'40"	65 38°27'6"	64 39°32'55"
	63 40°37'15"	62 41°40'12"	61 42°41'52"	60 43°42'23"	59 44°41'47"														
84	83 8°50'59"	82 12°31'40"	81 15°21'32"	80 17°45'10"	79 19°52'6"	78 21°47'12"	77 23°33'23"	76 25°12'32"	75 26°45'56"	74 28°14'33"	73 29°39'7"	72 31°0'10"	71 32°18'9"	70 33°33'26"	69 34°46'19"	68 35°57'2"	67 37°5'48"	66 38°12'48"	65 39°18'10"
	64 40°22'3"	63 41°24'35"	62 42°25'50"	61 43°25'55"	60 44°24'55"														
85	84 8°47'51"	83 12°27'13"	82 15°16'4"	81 17°38'50"	80 19°45'0"	79 21°39'24"	78 23°24'56"	77 25°3'27"	76 26°36'17"	75 28°4'21"	74 29°28'23"	73 30°48'55"	72 32°6'25"	71 33°21'13"	70 34°33'37"	69 35°43'53"	68 36°52'12"	67 37°58'45"	66 39°3'41"
	65 40°7'9"	64 41°9'15"	63 42°10'6"	62 43°9'46"	61 44°8'22"														
86	85 8°44'46"	84 12°22'51"	83 15°10'41"	82 17°32'37"	81 19°38'1"	80 21°31'44"	79 23°16'37"	78 24°54'33"	77 26°26'48"	76 27°54'20"	75 29°17'50"	74 30°37'52"	73 31°54'52"	72 33°9'12"	71 34°21'9"	70 35°30'58"	69 36°38'50"	68 37°44'57"	67 38°48'28"
	66 39°52'31"	65 40°54'12"	64 41°54'39"	63 42°53'55"	62 43°52'7"	61 44°49'19"													
87	86 8°41'44"	85 12°18'33"	84 15°5'25"	83 17°26'30"	82 19°31'10"	81 21°24'12"	80 23°8'28"	79 24°45'48"	78 26°17'30"	77 27°44'29"	76 29°7'29"	75 30°27'1"	74 31°43'33"	73 32°57'25"	72 34°8'54"	71 35°18'16"	70 36°25'43"	69 37°31'25"	68 38°35'31"
	67 39°38'9"	66 40°39'26"	65 41°39'29"	64 42°38'22"	63 43°36'10"	62 44°32'58"													
88	87 8°38'45"	86 12°14'20"	85 15°0'13"	84 17°20'29"	83 19°24'25"	82 21°16'48"	81 23°0'27"	80 24°37'12"	79 26°8'21"	78 27°34'49"	77 28°57'18"	76 30°16'22"	75 31°32'25"	74 32°45'50"	73 33°56'53"	72 35°5'48"	71 36°12'50"	70 37°18'6"	69 38°21'48"
	68 39°24'2"	67 40°24'56"	66 41°24'35"	65 42°23'5"	64 43°20'30"	63 44°16'56"													
89	88 8°35'49"	87 12°10'10"	86 14°55'7"	85 17°14'35"	84 19°17'48"	83 21°9'31"	82 22°52'34"	81 24°28'45"	80 25°59'21"	79 27°25'18"	78 28°47'18"	77 30°5'53"	76 31°21'29"	75 32°34'26"	74 33°45'3"	73 34°53'34"	72 36°0'10"	71 37°5'2"	70 38°8'20"
	69 39°10'10"	68 40°10'40"	67 41°9'57"	66 42°8'4"	65 43°5'7"	64 44°1'11"	63 44°56'19"												
90	89 8°32'57"	88 12°6'5"	87 14°50'6"	86 17°8'46"	85 19°11'17"	84 21°2'22"	83 22°44'49"	82 24°20'26"	81 25°50'31"	80 27°15'58"	79 28°37'28"	78 29°55'35"	77 31°10'44"	76 32°23'15"	75 33°33'26"	74 34°41'32"	73 35°47'43"	72 36°52'12"	71 37°55'6"
	70 38°56'33"	69 39°56'40"	68 40°55'34"	67 41°53'19"	66 42°50'0"	65 43°45'42"	64 44°40'29"												
91	90 8°30'7"	89 12°2'4"	88 14°45'11"	87 17°3'4"	86 19°4'53"	85 20°55'20"	84 22°37'12"	83 24°12'16"	82 25°41'50"	81 27°6'47"	80 28°27'49"	79 29°45'28"	78 31°0'10"	77 32°12'15"	76 33°22'1"	75 34°29'42"	74 35°35'30"	73 36°39'34"	72 37°42'5"
	71 38°43'9"	70 39°42'54"	69 40°41'26"	68 41°38'49"	67 42°35'9"	66 43°30'30"	65 44°24'55"												
92	91 8°27'20"	90 11°58'7"	89 14°40'19"	88 16°57'27"	87 18°58'35"	86 20°48'25"	85 22°29'42"	84 24°4'14"	83 25°33'17"	82 26°57'45"	81 28°18'19"	80 29°35'31"	79 30°49'46"	78 32°1'26"	77 33°10'48"	76 34°18'4"	75 35°23'28"	74 36°27'10"	73 37°29'18"
	72 38°30'0"	71 39°29'23"	70 40°27'33"	69 41°24'35"	68 42°20'33"	67 43°15'33"	66 44°9'38"												
93	92 8°24'35"	91 11°54'14"	90 14°35'33"	89 16°51'55"	88 18°52'24"	87 20°41'37"	86 22°22'20"	85 23°56'20"	84 25°24'53"	83 26°48'52"	82 28°8'58"	81 29°25'43"	80 30°39'33"	79 31°50'48"	78 32°59'45"	77 34°6'38"	76 35°11'39"	75 36°14'58"	74 37°16'43"
	73 38°17'3"	72 39°16'5"	71 40°13'53"	70 41°10'34"	69 42°6'12"	68 43°0'52"	67 43°54'36"	66 44°47'29"											
94	93 8°21'54"	92 11°50'25"	91 14°30'51"	90 16°46'29"	89 18°46'18"	88 20°34'55"	87 22°15'5"	86 23°48'34"	85 25°16'37"	84 26°40'7"	83 27°59'46"	82 29°16'6"	81 30°29'30"	80 31°40'21"	79 32°48'54"	78 33°55'23"	77 35°0'1"	76 36°2'58"	75 37°4'21"
	74 38°4'20"	73 39°3'0"	72 40°0'28"	71 40°56'48"	70 41°52'6"	69 42°46'25"	68 43°39'49"	67 44°32'23"											
95	94 8°19'14"	93 11°46'39"	92 14°26'14"	91 16°41'8"	90 18°40'18"	89 20°28'20"	88 22°7'57"	87 23°40'55"	86 25°8'28"	85 26°31'31"	84 27°50'44"	83 29°6'37"	82 30°19'37"	81 31°30'3"	80 32°38'13"	79 33°44'19"	78 34°48'35"	77 35°51'9"	76 36°52'12"
	75 37°51'49"	74 38°50'9"	73 39°47'16"	72 40°43'16"	71 41°38'13"	70 42°32'13"	69 43°25'18"	68 44°17'31"											

Total Teeth in Spur Gears	Total Number of Teeth and Helix Angle of Pair of Helical Gears to Replace Spur Gears at Same Center Distance																		
96	95 8°16′38″	94 11°42′57″	93 14°21′41″	92 16°35′52″	91 18°34′24″	90 20°21′51″	89 22°0′55″	88 23°33′23″	87 25°0′28″	86 26°23′4″	85 27°41′50″	84 28°57′18″	83 30°9′53″	82 31°19′56″	81 32°27′42″	80 33°33′26″	79 34°37′20″	78 35°39′33″	77 36°40′14″
	76 37°39′30″	75 38°37′29″	74 39°34′16″	73 40°29′57″	72 41°24′35″	71 42°18′15″	70 43°11′0″	69 44°2′55″	68 44°54′2″										
97	96 8°14′3″	95 11°39′18″	94 14°17′13″	93 16°30′41″	92 18°28′35″	91 20°15′28″	90 21°54′1″	89 23°25′59″	88 24°52′35″	87 26°14′44″	86 27°33′4″	85 28°48′8″	84 30°0′19″	83 31°9′58″	82 32°17′22″	81 33°22′44″	80 34°26′15″	79 35°28′7″	78 36°28′27″
	77 37°27′24″	76 38°25′3″	75 39°21′30″	74 40°16′50″	73 41°11′9″	72 42°4′30″	71 42°56′57″	70 43°48′33″	69 44°39′21″										
98	97 8°11′31″	96 11°35′43″	95 14°12′48″	94 16°25′35″	93 18°22′52″	92 20°9′11″	91 21°47′12″	90 23°18′41″	89 24°44′50″	88 26°6′32″	87 27°24′27″	86 28°39′6″	85 29°50′54″	84 31°0′10″	83 32°7′11″	82 33°12′11″	81 34°15′22″	80 35°16′53″	79 36°16′52″
	78 37°15′28″	77 38°12′48″	76 39°8′55″	75 40°3′57″	74 40°57′57″	73 41°50′59″	72 42°43′7″	71 43°34′25″	70 44°24′55″										
99	98 8°9′2″	97 11°32′11″	96 14°8′28″	95 16°20′34″	94 18°17′14″	93 20°3′0″	92 21°40′30″	91 23°11′30″	90 24°37′12″	89 25°58′28″	88 27°15′58″	87 28°30′13″	86 29°41′37″	85 30°50′31″	84 31°57′10″	83 33°1′49″	82 34°4′38″	81 35°5′48″	80 36°5′28″
	79 37°3′45″	78 38°0′44″	77 38°56′33″	76 39°51′15″	75 40°44′57″	74 41°37′40″	73 42°29′31″	72 43°20′30″	71 44°10′43″										
100	99 8°6′35″	98 11°28′42″	97 14°4′12″	96 16°15′37″	95 18°11′42″	94 19°56′54″	93 21°33′55″	92 23°4′26″	91 24°29′41″	90 25°50′31″	89 27°7′36″	88 28°21′27″	87 29°32′29″	86 30°41′0″	85 31°47′18″	84 32°51′36″	83 33°54′5″	82 34°54′55″	81 35°54′15″
	80 36°52′12″	79 37°48′52″	78 38°44′22″	77 39°38′46″	76 40°32′9″	75 41°24′35″	74 42°16′7″	73 43°6′49″	72 43°56′44″	71 44°45′54″									
101	100 8°4′9″	99 11°25′16″	98 13°59′59″	97 16°10′44″	96 18°6′14″	95 19°50′54″	94 21°27′25″	93 22°57′28″	92 24°22′16″	91 25°42′41″	90 26°59′22″	89 28°12′50″	88 29°23′29″	87 30°31′39″	86 31°37′35″	85 32°41′32″	84 33°43′41″	83 34°44′11″	82 35°43′12″
	81 36°40′49″	80 37°37′11″	79 38°32′22″	78 39°26′28″	77 40°19′33″	76 41°11′41″	75 42°2′56″	74 42°53′20″	73 43°42′58″	72 44°31′52″									
102	101 8°1′46″	100 11°21′54″	99 13°55′50″	98 16°5′56″	97 18°0′51″	96 19°45′0″	95 21°21′1″	94 22°50′37″	93 24°14′59″	92 25°34′59″	91 26°51′16″	90 28°4′21″	89 29°14′38″	88 30°22′26″	87 31°28′1″	86 32°31′38″	85 33°33′26″	84 34°33′37″	83 35°32′18″
	82 36°29′38″	81 37°25′41″	80 38°20′34″	79 39°14′22″	78 40°7′9″	77 40°59′0″	76 41°49′57″	75 42°40′5″	74 43°29′25″	73 44°18′2″									
103	102 7°59′26″	101 11°18′34″	100 13°51′45″	99 16°1′12″	98 17°55′33″	97 19°39′10″	96 21°14′42″	95 22°43′51″	94 24°7′47″	93 25°27′23″	92 26°43′17″	91 27°55′59″	90 29°5′54″	89 30°13′21″	88 31°18′36″	87 32°21′52″	86 33°23′21″	85 34°23′13″	84 35°21′35″
	83 36°18′36″	82 37°14′21″	81 38°8′56″	80 39°2′26″	79 39°54′56″	78 40°46′30″	77 41°37′10″	76 42°27′1″	75 43°16′5″	74 44°4′25″	73 44°52′4″								
104	103 7°57′7″	102 11°15′17″	101 13°47′43″	100 15°56′32″	99 17°50′19″	98 19°33′26″	97 21°8′30″	96 22°37′12″	95 24°0′43″	94 25°19′54″	93 26°35′25″	92 27°47′45″	91 28°57′18″	90 30°4′24″	89 31°9′19″	88 32°12′15″	87 33°13′25″	86 34°12′58″	85 35°11′2″
	84 36°7′44″	83 37°3′11″	82 37°57′29″	81 38°50′42″	80 39°42′54″	79 40°34′11″	78 41°24′35″	77 42°14′9″	76 43°2′57″	75 43°51′1″	74 44°38′23″								
105	104 7°54′50″	103 11°12′3″	102 13°43′45″	101 15°51′57″	100 17°45′10″	99 19°27′47″	98 21°2′22″	97 22°30′38″	96 23°53′44″	95 25°12′32″	94 26°27′40″	93 27°39′38″	92 28°48′50″	91 29°55′35″	90 31°0′10″	89 32°2′47″	88 33°3′38″	87 34°2′52″	86 35°0′38″
	85 35°57′2″	84 36°52′12″	83 37°46′12″	82 38°39′8″	81 39°31′4″	80 40°22′3″	79 40°56′29″	78 42°1′29″	77 42°50′0″	76 43°37′48″	75 44°24′55″								
106	105 7°52′35″	104 11°8′52″	103 13°39′50″	102 15°47′25″	101 17°40′5″	100 19°22′12″	99 20°56′20″	98 22°24′10″	97 23°46′51″	96 25°5′15″	95 26°20′1″	94 27°31′38″	93 28°40′29″	92 29°46′54″	91 30°51′9″	90 31°53′27″	89 32°53′59″	88 33°52′55″	87 34°50′23″
	86 35°46′29″	85 36°41′22″	84 37°35′5″	83 38°27′44″	82 39°19′23″	81 40°10′7″	80 40°59′58″	79 41°49′0″	78 42°37′15″	77 43°24′48″	76 44°11′39″	75 44°57′51″							
107	106 7°50′22″	105 11°5′43″	104 13°35′59″	103 15°42′57″	102 17°35′5″	101 19°16′42″	100 20°50′23″	99 22°17′47″	98 23°40′4″	97 24°58′6″	96 26°12′29″	95 27°23′44″	94 28°32′15″	93 29°38′20″	92 30°42′16″	91 31°44′15″	90 32°44′29″	89 33°43′6″	88 34°40′16″
	87 35°36′6″	86 36°30′41″	85 37°24′8″	84 38°16′30″	83 39°7′53″	82 39°58′20″	81 40°47′55″	80 41°36′42″	79 42°24′42″	78 43°11′59″	77 43°58′35″	76 14°44′32″							

new parts and materials

For additional information on this new equipment see Page 167

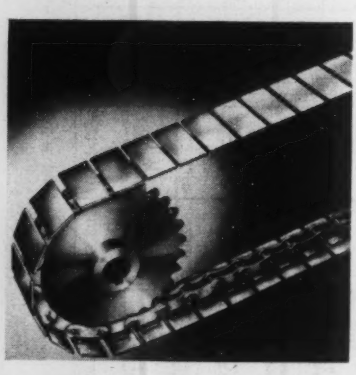
Geared Speed Reducer



Having output capacity of ½ hp with 1000 lb-in. torque, model CW-2 is double-reduction horizontal speed reducer. Capacity varies, however, with ratio which has range of from 10:1 to 3840:1. Input and output shaft diameters are ⅝ and 1-inch, respectively; and oversize shafts are available upon specification. Features include aluminum alloy housings, phosphor bronze worm gears, 20-degree pressure angle gearing, ground-thread worms and Timken roller bearings. Manufacturer: Euclid Universal Machine Inc., 15002 Woodworth Rd., Cleveland 10, O.

For additional information circle MD 1 on Page 167

Platform Conveyor Chain



Suitable for unit conveying of bottles, cans, and small packaged goods, new platform conveyor chain insures smooth steady travel. Tapered head-pins facilitate assembly and disassembly and eliminate spreading of side plates. Top plates have a beveled edge to assure safe transfer of materials. Cotter keys on one side of the chain make installation and maintenance easier. The roller chain construction has no hinge joints operating under tension, and absorbs and cushions shock loads. All-welded construction keeps the chains clean and sanitary. Manufacturer: Whitney Chain & Mfg. Co., Hartford 2, Conn.

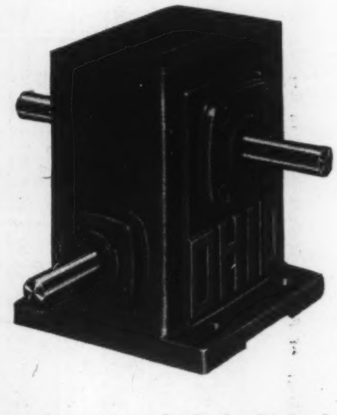
For additional information circle MD 2 on Page 167

Horizontal Type Carburetors

Horizontal carburetor of high angularity design is constructed for balanced air flow, i.e., all air for fuel chamber venting, metering well venting and idling must pass through air cleaner. Air cleaner restrictions have minimum influence on fuel-air ratio because of balanced design. Carburetors in 10-Series are available in one barrel size and 2 sizes of SAE flanges; model 10A5 has ⅝-inch barrel and SAE nominal size of ⅝-inch. Model 10AY5 has ⅝-inch barrel but flange size is special. Letter A in all models indicates that throttle and air shutter shafts are parallel. Manufacturer: Zenith Carburetor Div., Bendix Aviation Corp., 696 Hart Ave., Detroit 14, Mich.

For additional information circle MD 3 on Page 167

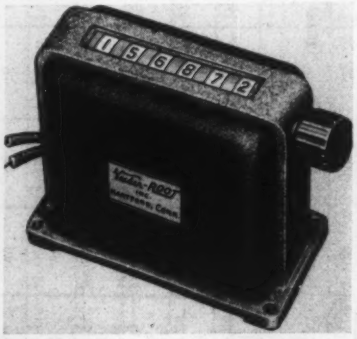
Single Reduction Speed Reducer



Small single reduction model BHS speed reducer is available in ratios from 6:1 to 58:1 with input from ⅛ to ⅝ hp. Unit is right-angle drive with input shaft below and worm gear or output shaft above. Output torque on 1800 rpm input ranges from 103 to 168 lb-in. Input shaft is ½-inch in diameter with 1⅝-inch extension, and output shaft is ⅝-inch in diameter with 1 15/16-inch extension. Base is 5 x 4¾ inches. Manufacturer: Ohio Gear Co., 1338 E. 179th St., Cleveland 10, O.

For additional information circle MD 4 on Page 167

Magnetic Counter

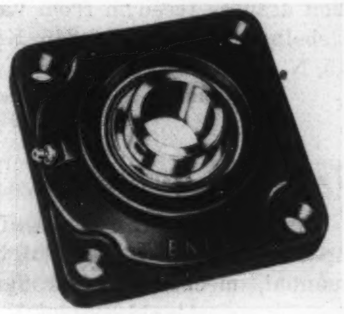


Measuring 3 15/16 x 2½ x 1⅝ inches, No. 1248 reset magnetic counter is adaptable to built-in installations as original product part. It is especially suitable for remote indication from plant to office. Direct reading at disance is facilitated by Easy-Eye line of six figures in large windows brought out by contrasting background of light gray band. Unit operates at speed of up to 1000 counts per minute. In addition to this model for d-c, No. 1205 having similar characteristics can be supplied for operation on 50-60-cycle 110-volt a-c. Manufacturer: Veeder-Root Inc., Hartford 2, Conn.

For additional information circle MD 5 on Page 167

Self-Aligning Bearings

Quick and simple installation, self-alignment and ease of servicing are design features of these pillow blocks and flanged cartridges (shown). Because of spherically ground outside diameter, bearing aligns itself on shaft. Alloy steel races and chrome alloy steel balls are used, and inner race is locked on shaft by two knurled cup-point set screws spaced 120 degrees apart. Labyrinth type oil-resistant seal integral with bearing excludes dirt, permits unrestricted misalignment and allows excess grease to escape without danger of blowing out seal. Prelubricated bearings in sizes for ½ to 1¼-inch shafts can be relubricated through Zerk fittings. Rigid mounting is provided by one-piece cast-iron housings. Manufacturer: Boston Gear Works, Quincy 71, Mass.



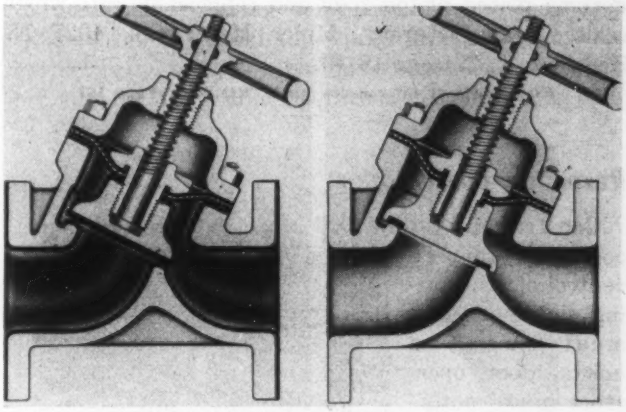
For additional information circle MD 6 on Page 167

Packless Diaphragm Valves

Packless diaphragm type valve is designed so that diaphragm functions as sealing bonnet only. Separate seating member gives positive control of flow independently of diaphragm. In event of diaphragm failure, fluid cannot pass on to line when valve is closed. Valve is particularly suitable for control of compressed air, compressed and liquefied gases, hard-to-hold fluids, corrosive and noxious gases, corrosive process fluids, solvents, natural and corrosive waters such as mine water, sludges, slurries, fluids containing abrasive materials, and pulp-and-paper mill liquors.

Two types of valves are available, one plain iron and other neoprene lined and coated, both having bolted bonnets. Plain iron valves are offered in sizes of ½ to 2 inches with screwed ends and ½ to 4 inches with flanged ends. Neoprene-lined-and-coated valves are available with flanged ends only in sizes of ½ to 4 inches. Sizes 2 inches and under have stem rising through handwheel, and larger sizes have handwheel rigidly attached to stem and rising with it.

Plain iron valves are designed for services not exceeding 150 psi and 180 F. Temperature limitations on neoprene-lined-and-coated valves are dependent upon service conditions and fluids carried. Where abrasive dusts are present or where there is danger from rock slides such as in mine operations, cap to protect stem threads can be supplied for valves of 2-inch and smaller sizes. Manufacturer: Crane Co., 836 S. Michigan Ave., Chicago 5, Ill.



For additional information circle MD 7 on Page 167

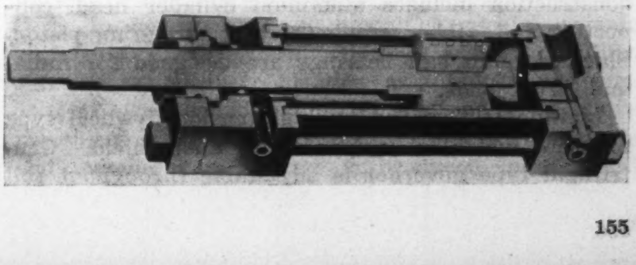
Rubber-To-Metal Bonding

Recommended for applications involving hot or cold liquids or gases, silicone rubber bonded to metal will withstand temperatures ranging from −160 to 500 F. Illustration shows layer of silicone rubber joined to periphery of aluminum casting. This bonding method suggests possible uses of bonded silicone-metal parts as gaskets for industrial ovens and refrigerating equipment, as diaphragms to seal lubricants in bearings, and as machine elements where extreme temperatures are involved. Because of dielectric qualities, silicone-metal electrical parts are practical. Manufacturer: Stalwart Rubber Co., 180 Northfield Rd., Bedford, O.

For additional information circle MD 8 on Page 167

Hydraulic Cylinders

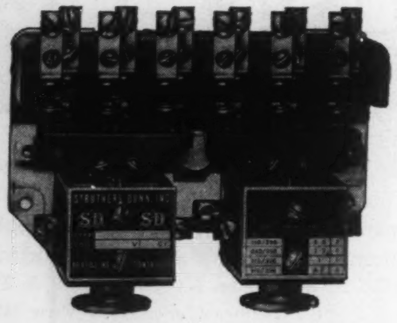
Standard models of 10 and 12-inch bore hydraulic cylinders for operation on 2500 to 3500 psi service are available from stock. They include single and double rod end styles and choice of piston and piston rod seals for different applications. Features include nonbreakable steel heads, caps and mountings; hard-



chrome plated piston rods and replaceable dirt wiper seals. Manufacturer: Miller Motor Co., 4027 N. Kedzie Ave., Chicago 18, Ill.

For additional information circle MD 9 on Page 167

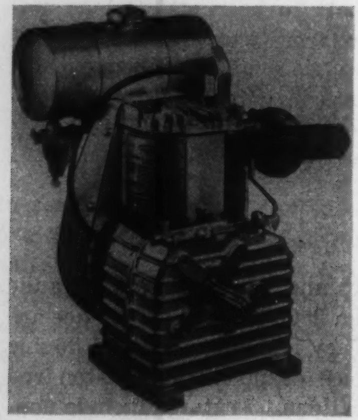
Reversing Contactor



Constructed for continuous duty control of alternating and d-c equipment such as hoists, door operators and motorized valves, type 175KXX reversing contactor is especially suitable for built-in applications and is readily serviceable from the front. Control consists of two 3-pole solenoids for forward and reverse operation mounted on common frame and mechanically interlocked to prevent simultaneous operation. Contacts are insulated with Melamine to minimize arcing damage. Open arc chutes allow rapid cooling and escape of ionized gases. Available ratings are 1 hp on 115 or 230-volt single phase a-c, 2 hp on 110 or 220-volt polyphase a-c, 1 hp on 440 or 550-volt polyphase a-c, and 1 hp on 115 or 230-volt d-c. Auxiliary contacts can be added for electric lock-up or interlock. All fixed contacts are interchangeable as are moving contacts and corresponding parts on each solenoid. Manufacturer: Struthers-Dunn Inc., 150 N. Thirteenth St., Philadelphia 7, Pa.

For additional information circle MD 10 on Page 167

Gasoline Engine



Power for saws, pumps, hoists, conveyors and other portable or mobile equipment is provided by this model 12 Utilimotor gasoline engine which is of air-cooled four-cycle type rated 1½ hp at 2300 rpm and 2 hp at 3000 rpm. Weighing only 38 pounds, engine measures 16 inches in height from base to filler cap of ½-gallon fuel tank. Standard construction includes aluminum cylinder head, connecting rod, ribber crankcase and three-ring piston. Shielded main ball bearings are designed for radial and thrust loads.

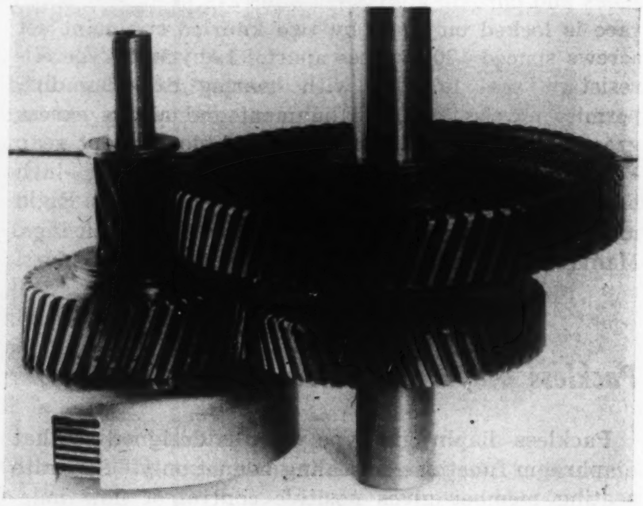
Ignition is provided by high-tension flywheel type magneto which is equipped with dust shield. Centrifugal type governor is adjustable throughout full power range and has provision for remote cable control. Splash oil system is supplemented by centrifugal oil slinger to assure lubrication. Angular valves permit compression ratio of 6.13 to 1. Built-in flywheel puller facilitates servicing.

In addition to standard model illustrated, engine is available with 6 to 1 geared speed reducer, with other ratio reducers available to order. Balanced construction assures freedom from vibration. Manufacturer: Uebelhoer Bros. Inc., 846 Kensington Ave., Buffalo 15, N. Y.

For additional information circle MD 11 on Page 167

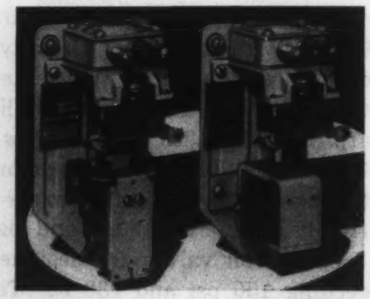
Two-Speed Transmission

Transmission can be shifted from a low gear speed ratio of 0.14 to a high gear ratio of 0.76 by manual, mechanical (through cam actuation), hydraulic, or solenoid control. Ratio of high to low speed is 5.4 to 1, or can be varied to meet any specific requirements. A disk clutch permits the gears, which are always in mesh, to shift from one speed to the other smoothly and quietly. Manufacturer: Eclipse Machine Div., Bendix Aviation Corp., Elmira, N. Y.



For additional information circle MD 12 on Page 167

Pneumatic Timer



Having timing period adjustable from 0.2-second to 3 minutes, class 9050 d-c pneumatic timer is useful for timing motor acceleration, machine sequences, process industry operations, resistance welds and numerous similar functions. It is accurate with less than 10 per cent variation from mean timing period and is unaffected by normal changes in voltage and ambient temperature. Timing period is set

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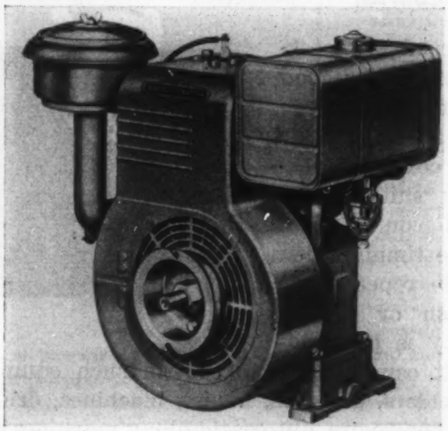
quickly by knurled knob or micrometer dial. Unit is normally open or closed, has snap action contacts and is contained in arc-resistant melamine case. Electrical interlocks, operated by magnet which actuates timing mechanism, frequently eliminate need for additional switching relays, and timer can be arranged for time delay after energization or de-energization of magnet. Manufacturer: Square D Co., 4041 N. Richards St., Milwaukee 12, Wis.

For additional information circle MD 13 on Page 167

Small Gasoline Engine

Suitable for powering many different types of machines, tools and equipment used in industry, in construction work and on railroads, models 9, 14 and 23 four-cycle air-cooled gasoline engines have ratings based on standard ICEI procedures of 2.16 to 3.1, 3.56 to 5.1 and 6.5 to 8.25 hp, respectively. Magnematic ignition system produces high voltage at low speeds and incorporates automatic spark retard and advance to assure quick pull-up starting without spinning. Breaker box unit externally mounted on crankcase encloses adjustable breaker points, condenser, manual stop switch and remote stop switch terminal.



Standard engines are available with plain or ball main bearings. Enclosed adjustable governor operating in oil provides speed regulation, and vacuum breather and spring loaded oil seals prevent oil leaks. Handy snap-on oil filler cap eliminates need for wrench when adding or changing oil. Starter rope or hand crank, or both, can be furnished. Manufacturer: Briggs & Stratton Corp., Milwaukee, Wis.

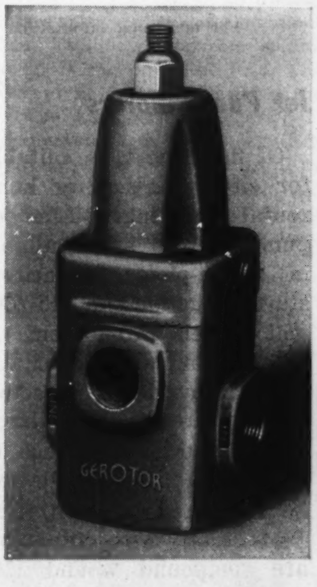
For additional information circle MD 14 on Page 167

Miniature Servo Motors

This d-c subminiature servo motor delivering 1/500-hp receives its current from plate circuits of a small vacuum tube amplifier. Designated RBDS-0810, motor measures 1⅝ inches in diameter and 2 9/16 inches between hubs, weighs 8½ oz, and operates on field current of 6 milliamperes with stalled armature current of 0.8-amp. Designed for aircraft instrument operation, motor has operating range from sea level to 40,000 ft covering temperature variations from −65 to 160 F. Maximum speed is 14,000 rpm. Two hermetically sealed, high-impendance field windings provide for reversible operation. Armature is operated from separate source of current to maintain maximum sensitivity, air gap between armature and field being very short. Manufacturer: Holtzer-Cabot Inc., Boston, Mass.

For additional information circle MD 15 on Page 167

Hydraulic Sequence Valve



Flow into branch circuit is prevented by model 8822 oil-hydraulic sequence valve until pressure in main circuit has reached predetermined amount. Directly operated by pressure in "in" port, valve is available in pressure ranges of 50 to 500 psi and 500 to 1500 psi with adjustment from minimum to maximum in both ranges. Seven sizes range from ¼ to 1½-inches. Valve incorporates hydraulically balanced piston with large bearing surface; spring guide; hardened, ground and lapped plunger; single diameter bore; piston stop; and large diameter plunger. Manufacturer: Gerotor May Corp., Baltimore 3, Md.

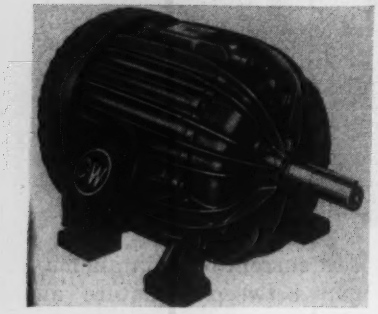
For additional information circle MD 16 on Page 167

Corrosion-Resistant Stainless Steel

Because of its high resistance to corrosive effects of sulphuric acid as well as to many other substances, Carpenter stainless steel No. 20 has numerous applications in manufacture of heavy chemicals, organic chemicals, synthetic rubber, high octane gasoline, solvents, explosives, plastics and pharmaceuticals. Typical uses include pump shafts and rods, valve parts, screens, pipe lines, heat exchangers, fume ducts and exhaust fans. Sheet is produced in standard widths and lengths in gages from 24 to 11, while plate is produced in thicknesses from 3/16-inch up. Manufacturer: Carpenter Steel Co., Alloy Tube Div., Union, N. J.

For additional information circle MD 17 on Page 167

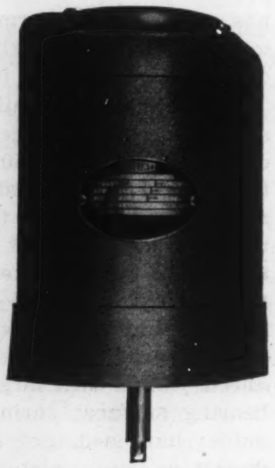
Totally-Enclosed Motors and Gearmotors



Addition of NEMA frame sizes 404-405 and 504-505 extends line of form CFC Sealedpower totally-enclosed fan - cooled motors to include ratings up to 100 hp. Externally mounted fan blows cooling air along ribs on outside of frame and end shields. Ribbed design affords 150 per cent more heat-dissipating surface than conventional round frame construction. Manufacturer: Crocker-Wheeler Electric Mfg. Co., Div. Joshua Hendy Corp., Ampere, N. J.

For additional information circle MD 18 on Page 167

Jet Pump Motors



Of flat face type suitable for either vertical or horizontal mounting, B-Line jet pump motors are available in single-phase, capacitor-start, induction-run 115-230-volt models rated from $^1/_6$ to 1 hp and with automatic thermal overload protector. Two or three-phase squirrel-cage induction types to operate on 220-440 volts can be furnished in sizes from ½ to 1 hp. Also obtainable are compound wound 115-230-volt d-c motors from ½ to 1 hp. All motors have standard NEMA dimensions and operate at 3450 rpm at 60 cycles and 2850 rpm at 50 cycles. Manufacturer: Brown-Brockmeyer Co., Dayton 1, O.

For additional information circle MD 19 on Page 167

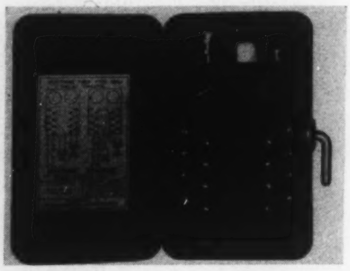
Extruded And Molded Rubber

Gaskets, diaphragms, grommets, washers, seals, packings, tubing and numerous other extruded or molded products are available made of X-7 silicone which offers high resistance to permanent compression. In addition to being suitable for dielectric applications, this material is unaffected by temperatures ranging from −160 to 500 F and retains its rubber-like qualities in this range.

Parts resist chemical action of lubricating oils and many chemicals. They do not become brittle and will not crack after long exposure to air, ultraviolet rays or ozone. Manufacturer: Stalwart Rubber Co., 180 Northfield Rd., Bedford, O.

For additional information circle MD 20 on Page 167

Timer Control



Designed for intervals from 1/20-second to 4 minutes, type 30HL1 automatic timing control is especially suitable for process control and machine timing when long life repeat-cycle operation or precise accuracy is prerequisite. It can be used to control such equipment as spot welders, grinders, honing machines, drilling machines, conveyors, automatic filling machines and photographic printers. Device provides interval, delayed action, automatic repeat and programming timing as well as many variations of these four fundamental types.

Since basic circuit of timer is self-compensating for changes in line voltage, accuracy remains within 2 per cent. Either 115 or 230-volt, 50-60-cycle supply line can be used, and power required for operation is 25 watts. Output is controlled by two single-pole double-throw switches having relay contact rating of 10 amp., 115-volt a-c and auxiliary contact rating of 1 amp., 115-volt a-c. Manufacturer: Photoswitch Inc., 77 Broadway, Cambridge 42, Mass.

For additional information circle MD 21 on Page 167

Flared Tube Unions

Designed to meet need for fast, lightweight connections in fluid lines, 1900 series single-thread quick-connecting tube unions are intended for joining flared tubing. Union is used with flared tube ends and con-

JOHNSON BRONZE

SLEEVE BEARING DATA

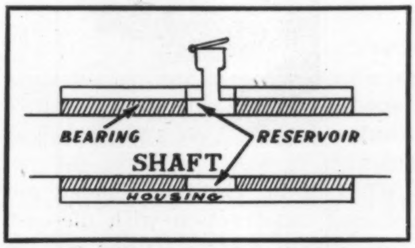
Bearing DESIGN

JOHNSON BRONZE

SLEEVE BEARING DATA

The Lubrication of Sleeve Type Bearings-2

NO *BEARING,* regardless of type, will operate satisfactorily or for any length of time without proper and dependable lubrication. The lubricant, as the life blood of every motive unit, should be the correct type, the right consistency and always in the right place at the right time. Otherwise excessive heat, wear and friction will develop with eventual seizure and bearing failure. The most popular lubricating agent is oil, with grease in some applications and graphite, water or other fluids used to a lesser degree.



In applications where it is necessary to use a longer than usual bearing, we sometimes recommend the use of two short bearings with the intervening space to serve as an oil reservoir.

The ideal bearing application is one in which it is possible to achieve a state of fluid friction with the journal and the bearing completely separated. The only friction present then is in the shearing action of the layers of oil. Obviously such an application would only be possible where there are high speeds and light loads. But as all bearing applications are not ideal, the designer must have ways and means to come as close as possible to ideal lubricating action.

Obviously, the first step is to assemble all operating facts. Then the method of distributing the lubricant and the type of lubrication to be used can be decided. Fundamentally, there are four primary methods of distributing the lubricant when it is oil —i.e., force feed . . . splash . . . bath . . . and ring, chain or collar oiling. In selecting the method to use, the most important factor to bear in mind is reliability.

Force feed is sometimes referred to as circulating lubrication. It includes all applications wherein a continuous flow of oil is maintained throughout all bearing applications. In such systems the viscosity of the lubricant is an important feature. It is also necessary to provide some method of purifying the lubricant for repeated use. Other considerations include speed, which should be high enough to build an oil film; dissipation of heat; prevention of leakage and oil oxidation. In some cases it is advisable to provide an oil cooling system to maintain the proper operating temperature of the lubricant.

The splash system involves the use of a completely enclosed crankcase, usually a cooling system and a heavy oil. As lubrication is effected by dipping, this system must provide an indicator so that the proper oil level is always maintained.

In the bath system the operating parts are usually completely submerged in the lubricant. In this method practically the same factors are involved as in the splash method.

Ring, chain or collar oiling involves a system whereby the lubricant is carried from the reservoir to the bearing by a ring or collar that rotates with the shaft to an opening in the top of the bearing. In this system particular attention must be paid to the type of oil grooving of the bearing so that sufficient oil is carried into every part of the loaded bearing area.

Hand oiling can be utilized in some applications although it is usually best to provide an oil cup or a combination of cup and wick.

Up to this point methods of supplying oil lubrication have been outlined. However, in many applications, use must be made of grease due to the nature of the operating conditions. Grease is ordinarily used for rough machinery where usage is severe and clearances are not consistent, and in slow moving equipment since the laws of hydrodynamic action are ineffective.

It is recommended that greases be supplied by some pressure system or pressure guns, since adjustable grease cups give positive action.

In conjunction with lubricating systems consideration must also be given to prevent end or side leakage. This condition in bearings is undesirable because it reduces the load a bearing may safely carry and results in extensive oil waste which creates problems of cleanliness both on the machine and goods in process.

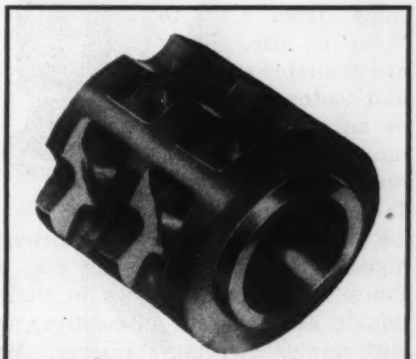
In order to prevent this condition use should be made of proper oil seals which, in addition to conserving oil, keep dirt from entering the machinery.

In all applications in which lubrication is required it is desirable that repeated use be made of the lubricant for reasons of economy. However, it must be remembered that oil is certainly to become contaminated while it is being used and this contamination definitely reduces the effectiveness and efficiency of the lubricant, resulting in injury to bearing surfaces.

Air, in the presence of hot oil, results in oxidation and the formation of sludge. These sludges are often acid in character and are injurious to the bearing linings. In many applications water is prevalent and in mixing with the lubricant tends to dilute the lubricant and make it ineffective as a load carrying medium. In addition, high temperatures are extremely destructive to oils and cause vaporization of the lighter constituent and the formation of carbon. In order to assure clean, suitable oil, two methods are generally used, that of filtering or separation by gravity.

Obviously some methods of lubrication are more expensive than others. There are many ways of reducing costs in designing machinery but the selection of an inferior or inadequate system of lubrication is not one of them. The most expensive bearing in the world is the one that fails. The easiest way to be certain of getting the greatest value and performance out of your bearing applications is to consult with Johnson Bronze. Our engineers are fully competent to give the proper advice and assistance on all your bearing problems. They will work with you without obligation.

In some bearing applications it is often possible and practical to provide recesses on the outside diameter of the bearing which serve as oil reservoirs.

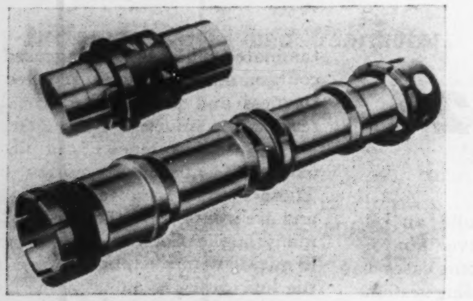


This bearing data sheet is but one of a series. You can get the complete set by writing to—

Johnson Bronze

SLEEVE BEARING HEADQUARTERS
525 S. MILL ST. • NEW CASTLE, PENNA.

sists of five parts: metal seal ring, two sleeves, threaded clamp ring, and mating coupling nut. Coupling nut incorporates visual inspection ports which lighten nut. Fast assembly is achieved by single-thread connection which is designed for use with standard commercial spanner wrenches. Unions are available in 1½, 2, 2½, 3 and 4-inch sizes, in either steel or aluminum alloy. Manufacturer: Roylyn Inc., 718 W. Wilson Ave., Glendale 3, Calif.



For additional information circle MD 22 on Page 167

Centrifugal Pumping Units

Starting with illustrated model H-2225 which delivers up to 3.4 gallons per hour, Superflo line of centrifugal pumps extends up to capacities of 70 gallons per minute at 10-foot head. Units are of immersion type and range from 1/25 to ½-hp in size. They are available as pump and motor units only or as complete units mounted in tanks. Illustrated type is only 7 inches high including motor. Since inlet is through top of impeller housing, flat base plate can rest on bottom of tank. Pump is designed for use in shallow sumps and for liquids of moderate viscosities, and it can be used with liquids carrying abrasives. Manufacturer: Graymills Corp., 2006 Ridge Ave., Evanston, Ill.

For additional information circle MD 23 on Page 167

Servo Motor

Adaptable to servo systems used in military and aircraft computers, radar equipment, automatic pilots, searchlight directors, fire control computers and various laboratory equipment, 400-cycle 115-volt two-phase four-pole induction servo motor has torque-to-inertia ratio of 26,300 radians per second per second. It delivers 2½ oz-in. stall torque which varies directly with control winding voltage, and it is capable of reversing in 0.2-second from 11,200 rpm. Motor will stop rotating when excitation of control winding is reduced to zero. It is 1¾ inches in diameter, 1¾ inches long and weighs 6.1 oz.

For applications where higher acceleration is more important than small size and light weight, larger servo motor of same design is available. It has torque-to-inertia ratio of 46,000 radians per second per second, stall torque of 3.8 oz-in., measures 2.3 inches in diameter by 2-3/16 inches long and weighs 15 oz. Manufacturer: Square D Co., Kollsman Instrument Div., 80-08 45th Ave., Elmhurst, N. Y.

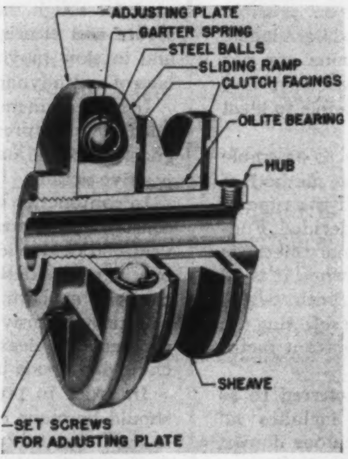
For additional information circle MD 24 on Page 167

Fractional Horsepower Motors

Added to line of electric motor products, six different small electric Micromotors are available for wide range of application. Features of these motors include humidity and oil-resistant coils, die-cast rotors, resilient rubber mounted bases, large oil reservoirs and finned die-cast or open ventilated drawn steel cases. Illustrated is type BT 1/30-hp two-pole shaded a-c motor of totally enclosed construction with die-cast case and enclosed fan cooling system. Other motors among additions to line range from 1/10 to 1/40-hp with speeds varying from 1000 to 3000 rpm, with one model designed for use on d-c. Manufacturer: Redmond Co. Inc., Owosso, Mich.

For additional information circle MD 25 on Page 167

Automatic Disk Type Clutch



Available with pulley or sprocket drive operating as main member, Gripmaster disk type automatic clutches find application in up to 10-hp lightweight agricultural equipment, power lawn mowers, concrete vibrators and mixers, power saws, motor bikes, compressors, refrigeration units and small power generator units. They are designed to engage at predetermined engine speeds and will handle maximum torque loads of engines with shaft sizes of ½ to 1½ inches.

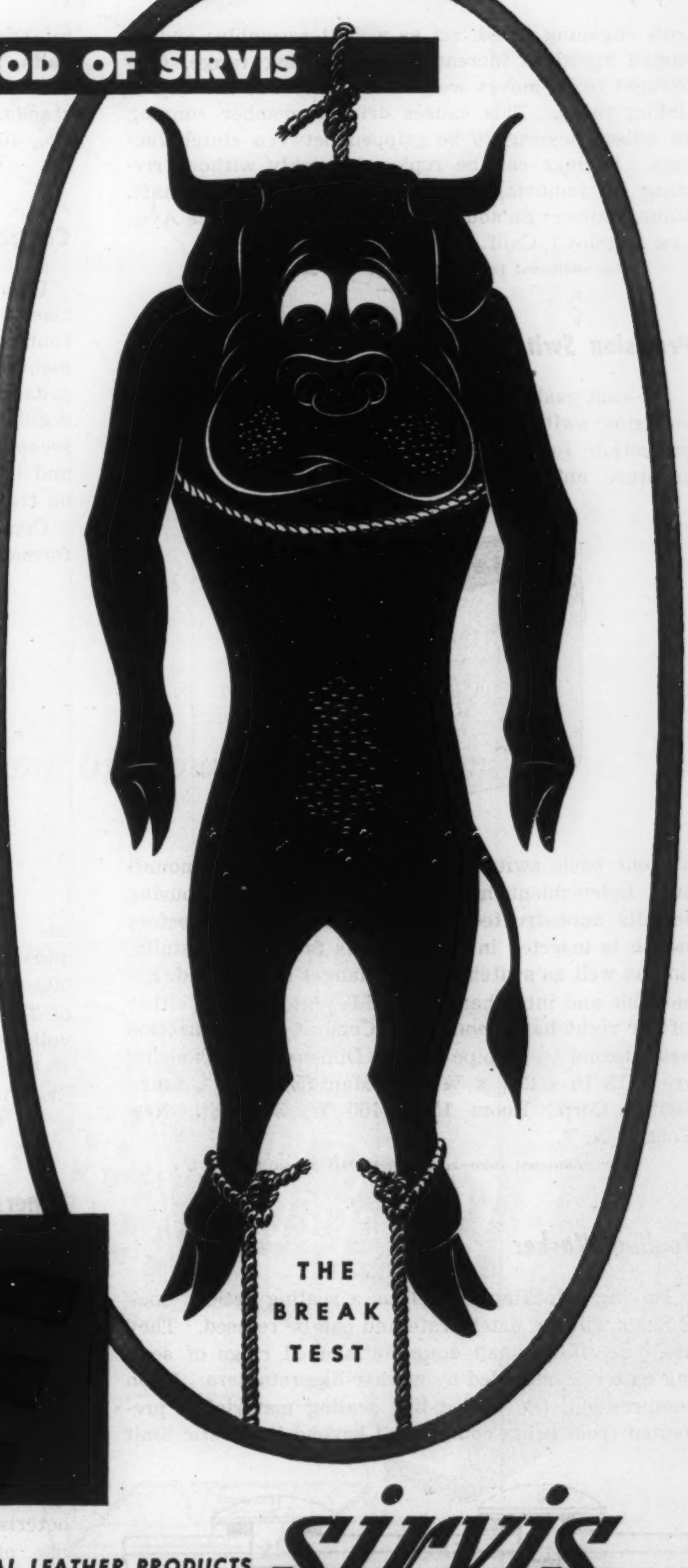
Steel balls enclosed in garter spring, which con-

IT'S ALL FOR THE GOOD OF SIRVIS

Stretching steers is out of our line. But, in testing Sirvis' tensile strength, steer*hide* is stretched until it breaks. Because Sirvis leather varies with tannage and treatments, each hide is given the break test to determine its suitability for varying applications. For example: a sample of steerhide being considered for transmission oil seals will be soaked in an "E. P." lubricant. The break test will then indicate the effects of this type of oil upon tensile strength. If the percentage of breakdown is well within the limits established for Sirvis oil seal leathers, the hide is certified for use. Similar immersion and break tests are conducted to determine the action of hot oil, water, salt solutions, and the many other liquids with which Sirvis leather parts must come in contact. In each case, the break test indicates the limits within which a given piece of hide can be used.

This is just one of the many laboratory-controlled tests to which Sirvis leathers are subjected . . . so that you may be assured of top quality in *packings, boots, gaskets, diaphragms and other mechanical leather products.* Because of extreme care in designing, excellence of materials, and constant checks in production, Sirvis mechanical leathers are outstanding in dependability.

- *For detailed information about Sirvis products, write for the free Chicago Rawhide catalog.*



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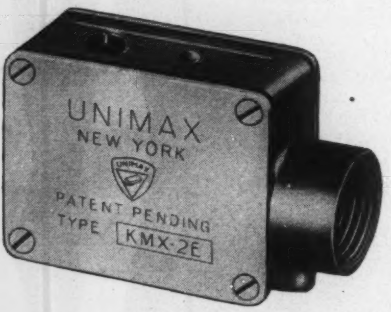
trols engaging speed, act as weight assembly; and as engine speed is increased above idling range, centrifugal force moves weight assembly out radially in sliding ramp. This causes driving member running on oilless bearing to be gripped between clutch facings. Facings can be replaced quickly without riveting or removing clutch from engine crankshaft. Manufacturer: Salsbury Corp., 1161 E. Florence Ave., Los Angeles 1, Calif.

For additional information circle MD 26 on Page 167

Precision Switch

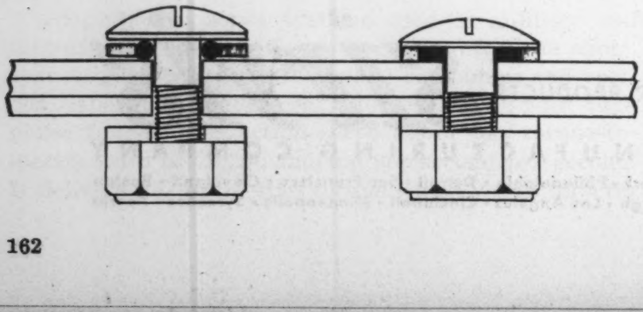
Die-cast gasketed aluminum housing of model KMX precision switch totally encloses and affords sealed protection for basic switch against splashing oil, moisture and abrasives. Housing can be installed without basic switch for either side or base mounting. Independent mounting of switch and housing permits unobstructed connection to terminals before switch is inserted into case. This facilitates installation as well as switch circuit changes as required. Removable and interchangeable side plates permit either left or right hand mounting. Conduit hub connection has internal ½-in. pipe thread. Dimensions of housing are 1 13/16 x 2¼ x ⅞-inch. Manufacturer: Unimax Switch Corp., Room 1510, 460 W. 34th St., New York 1, N. Y.



For additional information circle MD 27 on Page 167

Sealing Washer

Having a locking as well as a sealing action, Lock O Seals will not deteriorate and can be re-used. They are essentially small doughnut-shaped rings of sealing material encircled by washer-like retainers. Upon compression, the rubber-like sealing material is prevented from being compressed beyond its elastic limit by the metal retainer. Applicable around screws, bolts, rivets, tubing, electrical wires, etc., they provide the same full metal-to-metal bearing surface as standard washers. Manufacturer: Franklin C. Wolfe Co., 407 Commercial Center St., Beverly Hills, Calif.

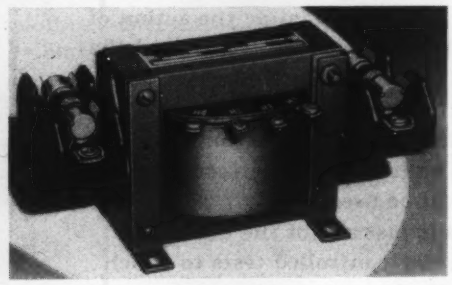


For additional information circle MD 28 on Page 167

Control Circuit Transformer

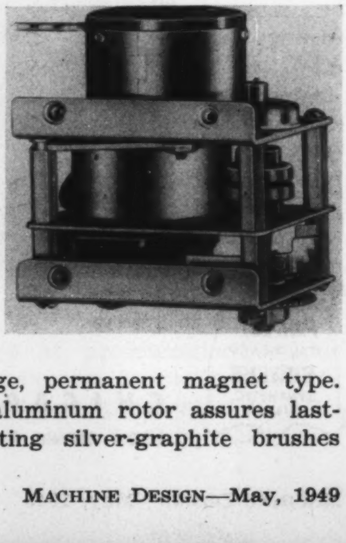
Line of control circuit transformers, designated class 9070 type A, is intended for use with industrial control equipment which is characterized by high momentary inrush currents to a-c magnet coils. Low impedance values of transformer windings result in good regulation during peak current periods. To provide secondary circuit protection, either one or two fuse and bracket assembly units can be mounted directly on transformer.

Compactly constructed and easily installed, transformers are designed for front-wired control panel use. They are available in ratings of 40, 100, 150 and 300 volt-amp at either 50-60 or 25 cycles and 500 volt-amp at 50-60 cycles, with primary voltages of 220-440, 550, 440, 380 and 220 volts and secondary voltages of 110 or 24 volts. Manufacturer: Square D Co., Industrial Controller Div., 4041 N. Richards St., Milwaukee 12, Wis.

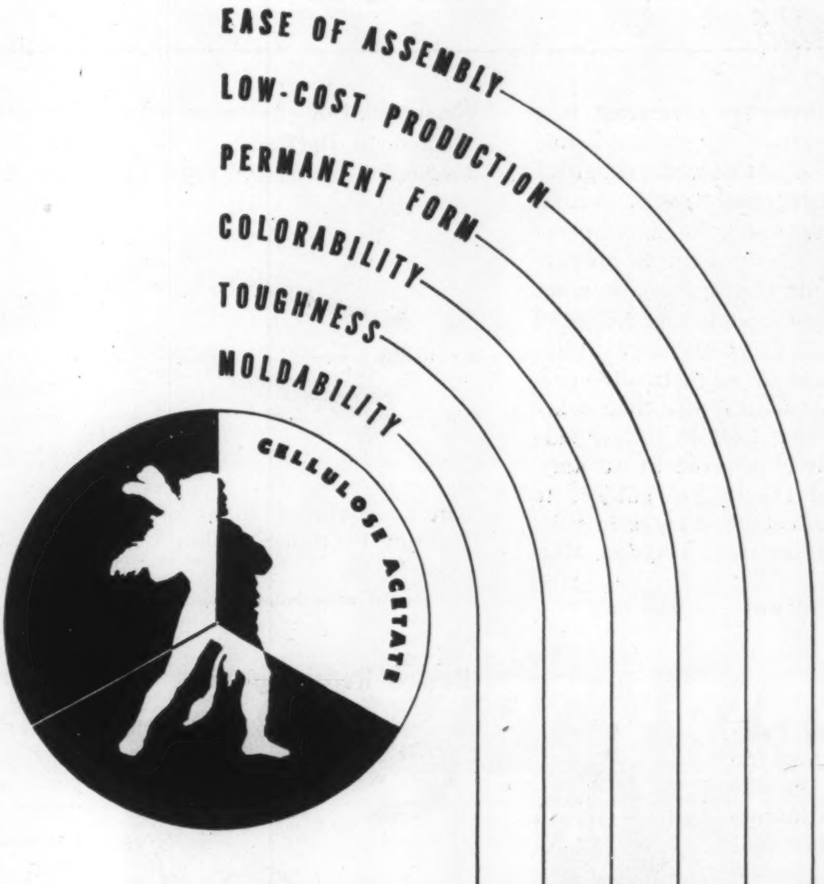


For additional information circle MD 29 on Page 167

Timers And Motors



Originally developed for aircraft and other military uses, d-c timers and motors have been redesigned and improved to meet various industrial timing requirements. Having uniform torque and speed characteristics without use of mechanical governor, 9200 series d-c motor is low-voltage, permanent magnet type. Alnico magnet within aluminum rotor assures lasting flux; two long-lasting silver-graphite brushes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PERMANENT FORM
COLORABILITY
TOUGHNESS
MOLDABILITY
CELLULOSE ACETATE

Cellulose Acetate transmits long life, low cost to intercom sets

Versatile cellulose acetate offers many product advantages to the designer of office equipment. Here, a design for a one-piece housing for an office intercommunication set simplifies molding and assembly; when in use provides easy access for adjustments and repairs. Acetate's rich color and lustrous, durable finish provide an attractive unit that will blend well with modern office furnishings.

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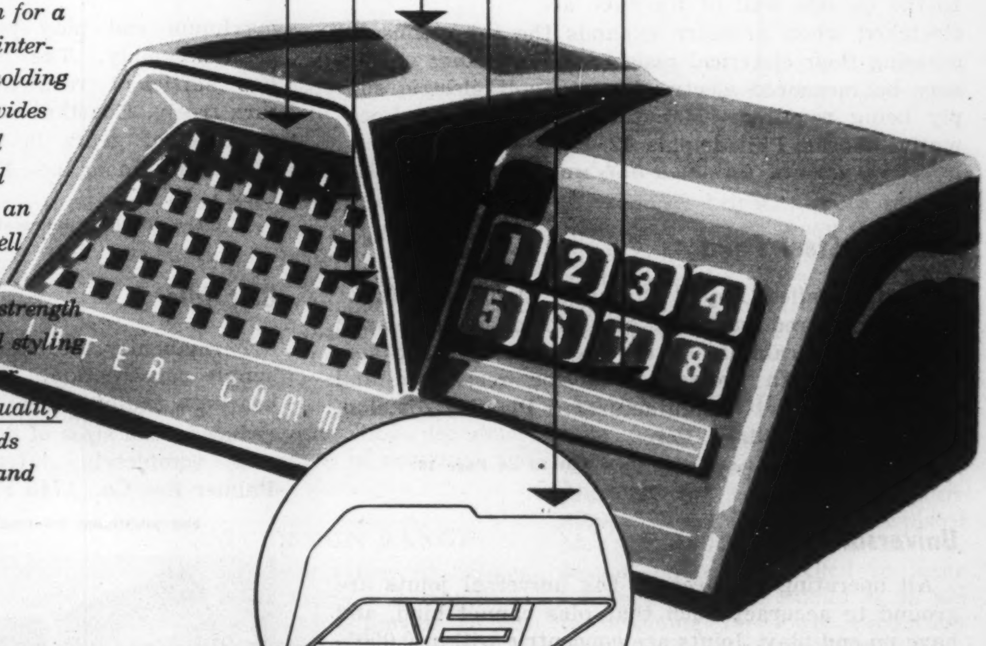
INTER-COMM
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Suggested design for intercommunication set, with one-piece molded housing, by Carl Sundberg, Sundberg & Ferar, Detroit, Mich.

HERCULES POWDER COMPANY
INCORPORATED
950 Market Street, Wilmington 99, Del.

supply armature current. Motors are reversible, lubricated for life and totally enclosed. Basic motor has speed of 900 rpm at 6-volts d-c, and wide range of speeds is possible with standard gear trains. Actual output speed varies with changes in voltage, temperature and load. These motors can be built to operate on voltages as high as 115 volts d-c. Automatic reset timers No. 5148 which is nonadjustable and No. 5149 which is adjustable over wide interval range utilize 9800 series d-c motors coupled to magnetically-operated clutch. They can be used with either time delay or interval timing by connecting load to proper side of double-throw switch. Switch is rated at 10 amp, 28 volts d-c. Both series of timers are subject to variations in timing due to effect of changes in voltage and temperature. Manufacturer: Haydon Mfg. Co., Torrington, Conn.

For additional information circle MD 30 on Page 167

Low-Range Pressure Cells

Three new type SR-4 Fluid Pressure Cells can be used for the measurement of pressures in the range 0 to 1000-psi. Calibration accuracy of all cells is ±¼ per cent of full range. Cells provide measurement in the ranges of 0-200, 0-500 and 0-1000 psi. They can be used in any gas or liquid pressure system by screwing into a tapped hole opening into the system. Resistance wire strain gages bonded to the outside wall of the tube are stretched when pressure expands the tube, thus increasing their electrical resistance. Resistance change may be measured electrically, a 4-volt electric supply being required. Manufacturer: Baldwin Locomotive Works, Philadelphia 42, Pa.

For additional information circle MD 31 on Page 167

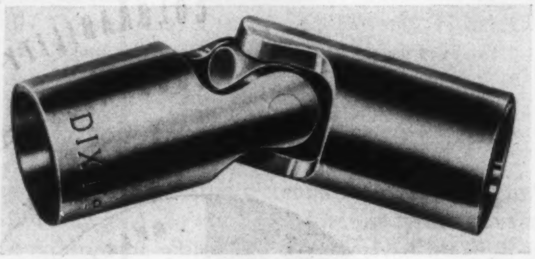
Stainless-Steel Paint

Coating called Liquid Stainless Steel consists of finely powdered stainless steel in a liquid plastic vehicle. Applicable to all types of materials and surfaces the finish provides corrosion resistance and good appearance. Manufacturer: Plastics division, Lockrey Co., College Point, N. Y.

For additional information circle MD 32 on Page 167

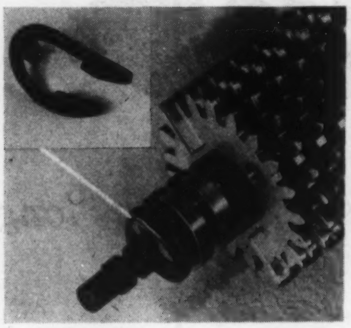
Universal Joint

All operating surfaces of Dix universal joints are ground to accuracy such that pins cannot bind, and have no end play. Joints are concentric within 0.0005-inch. Since all rivets are ground flush with body, joints can operate inside tubing or in close quarters. They are undercut to obtain greatest operating angle without sacrificing strength. Available in 14 standard sizes from ⅜ to 4-inch hub diameter, joints are constructed of alloy steel which is hardened and heat treated to Rockwell 38 C. On order, they can be Magnaflux tested and cadmium plated, and large sizes can be equipped with Zerk fittings. Manufacturer: Lovejoy Flexible Coupling Co., 5001 W. Lake St., Chicago 44, Ill.



For additional information circle MD 33 on Page 167

Bowed Retaining Ring



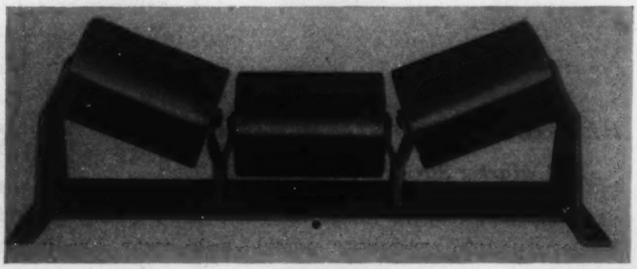
Gears and spacers may be accurately positioned on shafts using a new type bowed retaining ring. The new retainer, known as the Waldes Truarc Bowed "E" retaining ring type 5131, is a three-prong ring bent to a degree corresponding to the maximum end play provided by tolerance in the gear assembly. The bow takes up end play and has sufficient resilience to permit the gears to turn freely. Constant alignment of parts and accurate meshing of gears is thus assured. Manufacturer: Waldes Kohinoor Inc., 47-16 Austel Place, Long Island City 1, N. Y.

For additional information circle MD 34 on Page 167

Belt Idler

Permanently lubricated belt idler is sturdy and of simple construction. By the use of "life-lubricated" bearings, maintenance time is saved and repair cost reduced. All sizes of new idler are identical in design and completely interchangeable. Manufacturer: Palmer Bee Co., 1746 Poland St., Detroit 12.

For additional information circle MD 35 on Page 167



Designing for Sales

Nickeloid Metals Provide Both a New Material and a New Production Method

CARL C. STRUEVER
Gen. Mgr., American Nickeloid Company
Peru 8, Illinois

NICKELOID METALS provide two important sales advantages: First, lower unit costs; second, greater product beauty. They offer both a material and a production short-cut method of interest to every designer, every production and sales executive.

GREATER ECONOMY

NICKELOID METALS are *pre-finished* metals produced in sheets or coils and therefore more economical to use. No further plating, polishing or other finishing is required. The manufacturer need only fabricate to form a finished part or product. For normal production, NICKELOID METALS can be blanked, formed, drawn, stamped, bent, soldered, riveted or spot welded, without damage to the fine finishes. And for severe fabricating conditions the metal can be further provided with a "Mar-Not" protective coating — either a pressure sensitive paper, or a stripping type plastic film, either of which readily peels off after fabrication.

WIDE RANGE OF METALS

NICKELOID METALS are electroplated coatings of copper, brass, nickel or chromium on base metals such as zinc, steel, copper, brass or aluminum. Each NICKELOID METAL therefore is a combination that provides desirable properties such as surface beauty, rigidity, heat-resistance and other qualities. A full range of gauges and tempers allows for almost endless applications of decorative and functional use.

FULL DESIGN RANGE

With so much variety in finishes, basic metals, patterns and tempers — NICKELOID METALS provide endless opportunities for creative design. The interesting patterns can keynote a product design, or blend perfectly with an overall design, both for trim and utility. Designers will find in these metals inspiration for lending an added touch of beauty to any product.

APPLICATIONS ARE BROAD

Wherever bright, lustrous metal is desirable, and it almost *always* is, NICKELOID METALS can be considered. They are widely used in packaging, hardware, trim, stampings, housewares, signs, appliances, novelties.

LATEST STUDIES AVAILABLE

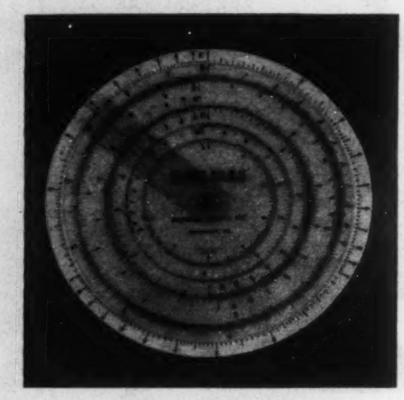
Available on request are late, complete studies on the properties, applications and latest fabrication techniques for NICKELOID pre-plated METALS, including metal samples. Manufacturers are invited to write for these complete studies as an aid to designing for lower production costs and increased salability.

AMERICAN *Nickeloid* COMPANY— Peru 8, Illinois

engineering dept equipment

For additional information on these new developments see Page 167

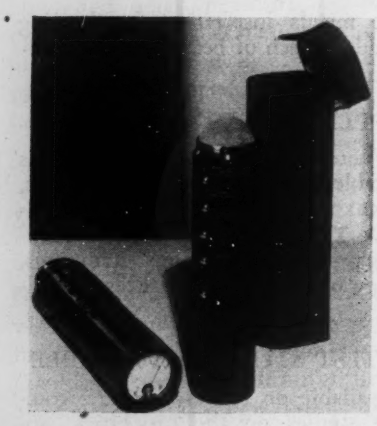
Circular Slide Rule



Measuring 4½ inches in diameter, circular slide rule is printed on durable laminated plastic. It is small enough to be carried in the pocket and only slightly less accurate than larger instruments. Operations possible include multiplication and division as well as determination of squares and square roots, cubes and cube roots, reciprocals and proportions. The inexpensive rule comes complete with instruction booklet and storage envelope. Manufacturer: Allegheny Plastics Inc., 334 Chestnut Rd., Sewickley, Pa.

For additional information circle MD 36 on Page 167

Portable Sound Level Meter

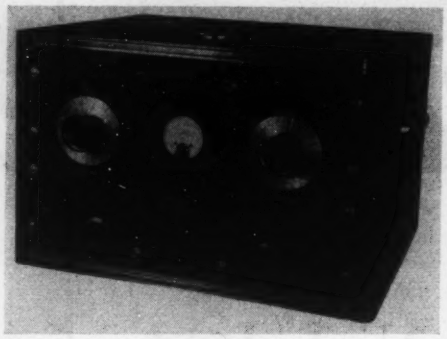


Easy and accurate measurement of noise levels is possible with flashlight-size type 410-A sound level meter which provides objective means of determining noise loudness in production testing of machinery and in establishing and maintaining design specifications. Powered by hearing aid batteries with normal operating life of 50 hours, meter covers range from 34 to 140 decibels above standard ASA reference level. It includes all three standard ASA weighting characteristics to duplicate response of ear at various levels and has two-speed meter, provision for using extension cable, optional types of microphones, vibration pickups, analyzers and filters. Unit is 11½ inches long and 2½ inches in diameter. Manufacturer: Hermon Hosmer Scott Inc., 385 Putnam Ave., Cambridge 39, Mass.

For additional information circle MD 37 on Page 167

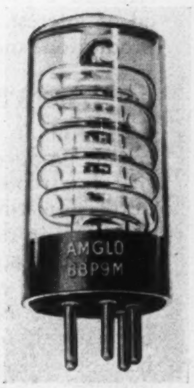
Servomechanism Test Instrument

Electronic servomechanism-test instrument known as the Servoscope provides continuous performance data. Frequency response can be plotted in a few minutes and transient characteristics deduced from this information. A modulated test signal of 0.25 to 16 cps is supplied by the instrument and routed through the mechanisms under test. Rapid measurement can then be made of frequency versus amplitude, attentuation and phase shift. Corrective networks and adjustments on the servos can be introduced without resorting to major revisions in the system. Visual display of signal amplitude and phase on an oscilloscope screen gives quick comparative value. Manufacturer: Servo Corporation of America, 2020 Jericho Turnpike, New Hyde Park, N. Y.



For additional information circle MD 38 on Page 167

Plastic Flash Lamp



Designed purposely for a-c and large, high-power portable electronic flash units, a new plastic flash lamp transmits about 45 million peak lumens at between 2000 and 2500 volts. Containing an auxiliary gas reservoir and extra large cathode, the novel lamp assures users of heavy duty service without operational failure. Maximum energy input is 300 watt-seconds, with high-voltage pulse as the discharge method. Carrying the designation 88P9M, the lamp measures 1½ inches in diameter, with a length of 3 inches, less the pins (five-pin base.) Manufacturer: Anglo Corp., 4234 Lincoln Ave., Chicago. 18, Ill.

For additional information circle MD 39 on Page 167

HELPFUL LITERATURE

FOR DESIGN EXECUTIVES

71. Electric Generators

Kato Engineering Co.—16-page illustrated booklet form No. 647 describes Katolight gas-engine driven electric plants, alternating and direct current generators, motor-generator sets, gas-engine driven battery chargers, alternating and direct current motors and rotary converters.

72. Strain Gage Control Unit

Hathaway Instrument Co.—12-page illustrated technical bulletin No. SP 195 presents information on type MRC-15 strain gage control unit which is 12-channel dynamic strain-analysis instrument complete with calibrating and balancing equipment for all needs in static-dynamic strain recording.

73. Small Machine Lubrication

Bijur Lubricating Corp.—24-page illustrated bulletin No. 4C describes how to design a lubricating system into small machines. Applications of system include many small machines ranging from zipper machines to radar equipment. Also discussed are meter-units which control oil feed down to fraction of a drop.

74. Capacitor-Start Motors

Emerson Electric Mfg. Co.—4-page illustrated bulletin No. X6157 presents details of construction of various parts of capacitor-start motors, complete dimensions, diagrams and performance in accordance with NEMA fractional horsepower motor standards.

75. Aluminum Castings

Monarch Aluminum Mfg. Co.—16-page illustracted brochure "Cavalcade of Casting Experience" describes and shows typical examples of aluminum permanent mold castings, aluminum diecastings and zinc diecastings. Casting and laboratory facilities are shown also.

76. Universal Joints

Borg-Warner Corp., Mechanics Universal Joint Div.—4-page mailing piece "A Size and Type for Every Use" describes line of roller-bearing universal joints for cars, trucks, busses and industrial equipment in sizes ranging from 200 to 50,000 pound-feet torque with wide variety of end connections and shaft arrangements.

77. Seamless Welding Fittings

Ladish Co.—112-page illustrated catalog Vol. 3 provides detailed information on types, sizes, weights and dimensions of seamless stainless steel and alloy pipe fittings. Technical data are included to simplify and speed up solutions to complex piping system design and operating problems.

78. Instrument Transformers

General Electric Co., Meter and Instrument Div.—80-page illustrated booklet GEA-4626B describes 107 types of instrument transformers, lists prices and ratings and gives ASA accuracy classifications for both indoor and outdoor use. Included are potential transformers, current transformers, metering outfits and portable transformers.

79. Overrunning Clutch

Kinney Mfg. Co.—2-page specification sheet and attached cross sectional drawing No. X456 describe multidisk overrunning clutch mechanism. It has drive plates spline-driven from shaft pinion, and its working pressure is applied automatically upon turn of driving shaft by balls actuated by cams.

80. Industrial Wire Cloth

Reynolds Wire Co.—40-page illustrated catalog B presents complete data on wire cloth which is shuttle-woven in plain, twilled or locked weaves; in aluminum, brass, bronze, phosphor bronze, copper, monel, nickel, plain steel, coated steel and stainless steel; and in all widths and lengths.

81. Sound-Level Meter

Hermon Hosmer Scott, Inc.—Form No. 41091 describes uses which sound-level meter has in engineering, selling, designing, building and production testing. Its specifications are listed as are various accessories which can be obtained for instrument.

82. Pre-Plated Metals

American Nickeloid Co.—4-page die-cut letter-size folder contains samples of metals finished in chrome, copper, nickel and brass and available on zinc, steel, copper, brass and aluminum bases. In addition, complete data are given on sizes of sheets, coils and flat strips obtainable. Designed for permanent filing. Sampler is enclosed in durable file folder.

83. Portable Thermal Meters

Rawson Electrical Instrument Co.—4-page illustrated bulletin No. 502 describes portable thermal meters and multimeters with vacuum thermocouples for measurement of alternating or direct current.

84. Adjustable Transformers

General Radio Co.—8-page illustrated mailing piece discusses application of Variac continuously adjustable transformers to all types of voltage, power, speed and heat control requirements.

85. High Speed Steels

Jessop Steel Co.—16-page illustrated catalog "Jessop High Speed Steels" discusses analyses, heat treatments and applications of five commonly used types of high speed steels. Charts depict hardness values after heat treatment.

86. Variable Speed Drive

Speed Control Corp.—6-page illustrated folder "Specon Variable Speed Transmissions with Infinite Speed Range" lists speed and torque of various models and gives dimensions to aid in application of these drive units.

87. Load Centers

Westinghouse Electric Corp.—4-page illustrated leaflet "MO-2 and MO-4 Multibreaker Loadcenters" announces availability from stock of two types of load centers and explains design features that provide for quick and easy installation and effective protection.

88. Insulated Wires & Cables

Rockbestos Products Corp.—96-page illustrated catalog No. 10-F is larger and more useful than 10-E edition which it supersedes. It lists more than 125 different heat and flame resistant wires, cable and cords of standard construction designed for severe operating conditions. Tabs separate sections for ready reference, and book contains many new features and added technical data.

89. Explosionproof Motor

Reliance Electric & Engineering Co.—4-page illustrated bulletin No. C-130 explains design features of explosionproof corrosion-resisting alternating current motor which is approved for class I, group D hazardous locations. It can be adapted also to meet specifications of Bureau of Mines for use on 'permissible' equipment.

90. Wire Rope

Jones & Laughlin Steel Corp.—96-page illustrated pocket-sized handbook "Wire Rope Is a Machine" explains how wire rope works, how it should be used and how to select and order correct wire rope construction for long service life on job.

91. Universal Joints

Blood-Brothers Machine Co.—50-page illustrated catalog No. 47 explains modern universal joint, its variety of uses, typical installations in well known industries, and design and construction of this particular joint.

FOR MORE INFORMATION

on developments in "New Parts" and "Engineering Department" sections—or if "Helpful Literature" is desired—circle corresponding numbers on either card below.

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92. Hydraulic Power Units

Denison Engineering Co.—4-page illustrated bulletin No. 133 gives details of HydrOILic pumps for pressures up to 5000 pounds per square inch; compact pumping units in capacities of 2 to 11 gallons per minute at pressures in range of 400 to 3000 pounds per square inch; fluid motors; pressure controls and directional control valves for hydraulic power installations.

93. Stress-Strain Recorders

Baldwin Locomotive Works—32-page illustrated bulletin No. 262 describes basic principles of various types of stress-strain recorders and strain followers and gives distinguishing features of 24 different recorders for all common makes of testing machines. Described also are more than 50 extensometers, compressometers and deflectometers that can be used with recorders.

94. Spherical Roller Bearings

Torrington Co.—28-page illustrated bulletin No. 200-A lists and describes applications of self-aligning spherical roller bearings. Other information including capacity ratings, life factors, service factors, speed factors, fits and combined thrust and radial loads is given.

95. Roller Chain

Atlas Chain & Mfg. Co.—12-page illustrated catalog "Atlas Roller Chain" discusses safety, wear and maintenance features of roller chain as well as its operating characteristics. Metallurgical characteristics are shown by photomicrographs, and specifications and prices are listed.

96. Air & Hydraulic Cylinders

Anker-Holth Mfg. Co.—168-page illustrated loose-leaf catalog contains complete engineering and design data on heavy-duty, tie rod, keeper flange and adjustable stroke nonrotating air cylinders; nonrotating hydraulic cylinders for pressures up to 3000 pounds per square inch; Air-Draulic cylinders and special types of air and hydraulic cylinders. Also covered are air actuated chucks and collets, controls and accessories.

97. Rustproofing

Parker Rust Proof Co.—44-page illustrated form A1221 presents new information on Bonderizing process and its applications on steel, aluminum, zinc and their alloys and on die-castings. Data are given also on Bonderite as aid in deep drawing of steel and aluminum.

98. Weld Pads

Ohio Nut & Bolt Co.—4-page illustrated bulletin No. 485 tabulates available sizes and dimensions of round, square and flange weld pads for projection welding to parts that require additional thickness in sheet metal sections where drilled or tapped holes are required. They are used also as mounting pads and as spacers.

99. Retaining Rings

Ramsey Corp.—Data sheet No. 1201 explains how machine components are held by Spirolox retaining rings and how they are spiraled into grooves without special tools. Listed also are available sizes of internal and external rings.

100. Pressure Relief Valves

Fluid Controls, Inc.—Four illustrated data sheets give specifications, operating characteristics, available capacities and other data on pilot type pressure relief valves which are adjustable.

101. Flexible Couplings

Estey Co.—2-page illustrated bulletin shows design and applications features of Estey Articulated flexible couplings.

102. Magnetic Contactors

Ward Leonard Electric Co.—4-page descriptive folder concerns bulletin Nos. 4454 and 4455 alternating current magnetic contactors for commercial and industrial control applications.

103. Motor Controls

Arrow-Hart & Hegeman Electric Co.—Packet of actual-size templates giving exact dimensions of line of starters, relays, transformers, terminal blocks and contactors facilitates visualizing space and size arrangements for installation of motor controls.

104. Small Electric Motors

Redmond Co., Inc.—4-page illustrated catalog 5M-3-49PL describes Type J 1/10-horsepower direct current MicroMotor having many applications in automotive industry for large heating, ventilating and defrosting units.

105. Self-Oiling Bearings

Bound Brook Oil-Less Bearing Co.—24-page illustrated size list No. 21 contains listing of all types and sizes of Compo oil-retaining porous bronze and Powdiron sintered iron bearings which can be produced from dies on hand, without tooling charge. Bearing metal formulas, tolerances and other data are included.

106. Automatic Hopper Feeds

Feedall Machine & Engineering Co.—4-page illustrated bulletin "For Increased Production" shows automatic feed hoppers applied to machines for feeding various types of work for machining, heating, forging and heading operations. These auxiliary units are self-contained.

107. Shaded Pole Motors

Russell Electric Co.—4-page three-color bulletin No. 4000 illustrates Raytheon type 470 six-pole motor with ratings from 1/30 to 1/8-horsepower at 1100 revolutions per minute. Included also is detailed description of important features, supplemented with performance curve.

108. Control Valves

Hydraulic Equipment Co.—4-page illustrated pamphlet file No. V 13-10948 presents data on Hydreco parallel circuit control valves having maximum capacity of 14 gallons per minute and recommended for operating pressures up to 1400 pounds per square inch.

109. Wire Cloth & Screen

Korb-Pettit Wire Fabrics & Iron Works, Inc. —44-page illustrated catalog No. 36 shows and describes square opening space screens; types of screen weaves and crimps; hooked edges; and double-crimp, square mesh market grade and extra fine wire cloth.

110. Thickness Gage

Sperry Products, Inc.—Illustrated bulletin No. 3700 deals with Reflectogage portable ultrasonic instrument for making nondestructive measurements of thickness of wide variety of materials from one side only.

111. Electric Meters

Sterling Mfg. Co.—8-page illustrated catalog No. 300 presents concise descriptions of pocket and panel type volt, ampere and testing meters; replacement automotive ammeters; battery cell tester and special meters.

112. Short Center Drives

J. E. Rhoads & Sons—16-page illustrated handbook "Rhoads Tannate-Rockwood Short Center Drive" describes drive which synchronizes belt tension with load, reduces effect of centrifugal belt tension, compensates for belt length variations and maintains high efficiency over wide range of loads and belt tensions.

113. Retaining Rings

Waldes Kohinoor Inc.—28-page illustrated catalog No. 4K-6(pt. 2) presents engineering specifications and data on Truarc retaining rings to facilitate proper selection and use of each type ring.

114. Electrical Equipment

Square D Co.—96-page illustrated "Catalog Digest" No. 131 replaces No. 130 dated August 1947. It is provided with thumb index for quick reference to various electrical equipment and accessories manufactured by company.

115. Low Pressure Cylinders

Hanna Engineering Works—20-page illustrated catalog No. 236 lists construction features, capacities and dimensional drawings of all standard size low pressure hydraulic cylinders and gives information on mounting brackets, cylinder cushions and cylinder selection.

116. Magnetic Amplifiers

Vickers Inc., Vickers Electric Div.—28-page illustrated bulletin No. VT-2000 is elementary description of magnetic amplifier circuits, their applications and recent developments. Included are introduction, glossary of terms and descriptions of many actual industrial circuits.

117. Permanent Magnets

General Electric Co.—38-page illustrated catalog CDM-2A presents information on stocked cast and sintered Alnico magnets as well as special magnetic alloys. Photographs and pull curves illustrate magnets, and property tables are included for reference.

118. Steel Fabrication

R. C. Mahon Co.—24-page illustrated booklet entitled "Steel-Weld Fabrication" describes facilities for fabricating massive bases, frames, mounts and numerous other parts previously produced in cast form. Included are number of recent advertisements which indicate scope of operations.

119. Galvanic Cell Corrosion

International Nickel Co.—8-page booklet explains reasons for galvanic cell corrosion as well as methods for helping to overcome it. It is complete in all engineering details and other essential illustrative material.

120. Springs & Wire Parts

Cuyahoga Spring Co. — 20-page illustrated catalog No. 49 contains design and application data on coil springs and wire parts. Technical spring data include table of standard wire gages; details of torsion, compression and extension springs; and descriptions of round and flat wire forms and assemblies, wire handles, fasteners and wire specialties.

M. D. Numbers

1	21	41	61	81	101
2	22	42	62	82	102
3	23	43	63	83	103
4	24	44	64	84	104
5	25	45	65	85	105
6	26	46	66	86	106
7	27	47	67	87	107
8	28	48	68	88	108
9	29	49	69	89	109
10	30	50	70	90	110
11	31	51	71	91	111
12	32	52	72	92	112
13	33	53	73	93	113
14	34	54	74	94	114
15	35	55	75	95	115
16	36	56	76	96	116
17	37	57	77	97	117
18	38	58	78	98	118
19	39	59	79	99	119
20	40	60	80	100	120

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TYPE "N" ROTARY SEAL

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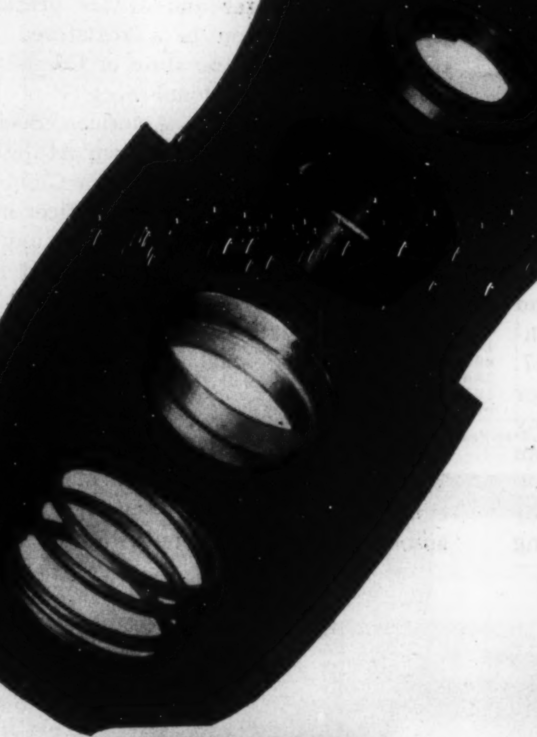
Type "N" eliminates "watchmaker" assembly jobs, by providing the seal pre-assembled and ready to incorporate into the equipment. This unit construction means no loose parts to deal with—no delicate adjustments or fittings to make. In short, type "N" Rotary Seals are thoroughly efficient *production-line* items. And if a replacement is occasionally required in the field, this same unit construction makes the job a simple one.

Rotary Seal engineers can quickly adapt this new seal to any of a wide range of applications. Inasmuch as type "N" has been designed particularly to meet mass production conditions, it is not available in small quantities for all shaft sizes.



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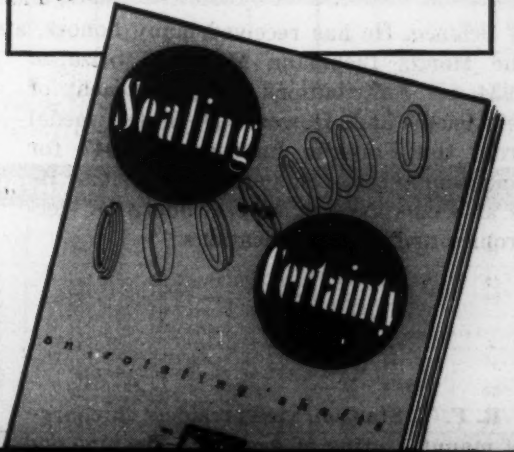

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mechanical seals for rotating shafts

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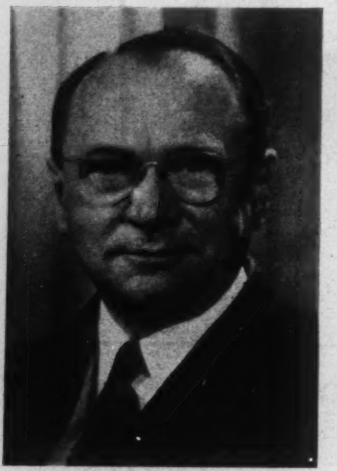

V. K. Zworykin

The 1948 Lamme Medal of the American Institute of Electrical Engineers has been awarded to **V. K. Zworykin**, vice president and technical consultant, RCA Laboratories Division, Radio Corporation of America, Princeton, N. J., "for his outstanding contribution to the concept and design of electronic apparatus basic to modern television." Dr. Zworykin, a native of Mourom, Russia, received his electrical engineering degree from Petrograd Institute of Technology, a Doctor of Philosophy degree from the University of Pittsburgh, and a Doctor of Science degree from Brooklyn Polytechnic Institute. From 1920 to 1929 he was associated with Westinghouse Electric and Manufacturing Co. in the research department, joining RCA in 1929 as director of electronic research. In 1942 he was made associate research director and became director of electronic research in 1946 and vice president and technical consultant in 1947. Dr. Zworykin is a member of the National Academy of Sciences, American Academy of Arts and Sciences, and French Academy of Science. He has received many honors, among them being the Morris Liebmann Memorial prize in 1934 for contributions to development of television, and Howard N. Potts medal from the Franklin Institute in 1947 for contributions to commercial television. He is also co-author of several books on electronics and their applications.

R. F. V. Stanton, vice president in charge of manufacturing of American Machine and Foundry Co., New York, has been elected a member of the company's board of directors. Mr. Stanton became associated with AMF as vice president in charge of production in the early part of 1948 after more than 30 years with the Pratt & Whitney Division of Niles-Bement-Pond Co., Hartford, Conn. After serving with the U. S. Marine Corps in the First World War he became production engineer of Pratt & Whitney and was promoted to production manager of the company's machine tool division in 1926. In 1935 Pratt & Whitney's president designated him for a special two-year assignment to formulate plans for a new plant at West Hartford. With the completion of this assignment in 1937, he was placed in charge of Pratt & Whitney's agency sales department until 1940 when he became manager of the contract division. In 1945 he was made assistant general sales manager and a vice president in 1947. Mr. Stanton is a registered professional engineer of the state of Connecticut, a member of the National Society of Professional Engineers, the American Society of Tool Engineers, the Downtown Athletic Club in New York and the Brooklyn Club. From 1927 to 1940 he was a reserve officer in Army Ordnance as a specialist in the manufacture of small arms. He was discharged in 1940 with a special order from the Secretary of War with a certificate of capacity for the rank of Lieutenant-Colonel.

R. F. V. Stanton

Emory N. Kemler

Appointment of **Emory N. Kemler**, New York, well known research and production engineer in petroleum and other fields as associate director of Southwest Research In-

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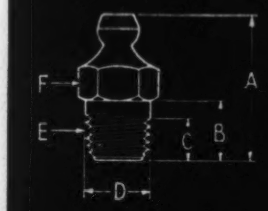

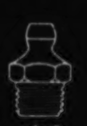
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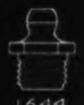
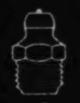
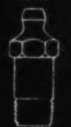

1644 Short Hex.


1980 Ball Check at Top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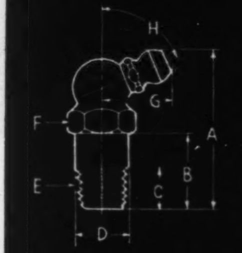

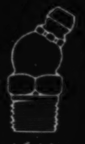
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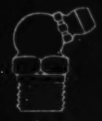
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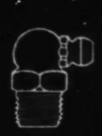
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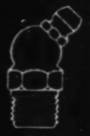
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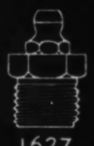
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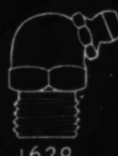
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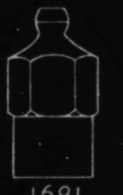
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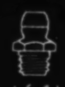
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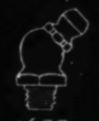
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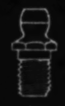
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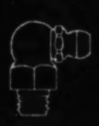
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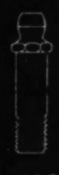
1698

STRAIGHT HYDRAULIC FITTINGS

Part No.	A	B	C	D	E†	F
1607	1 17/64"	25/32"	13/64"	13/32"	1/8" P.T.	7/16"
1610	3/4"	17/64"	13/64"	25/64"	1/8" P.T.	7/16"
1618	1 7/64"	5/16"	1/4"	1/2"	1/8" P.T. (Female)	1/2"
1634	13/16"	5/16"	1/4"	13/32"	1/8" P.T.	7/16"
1644	21/32"	5/16"	1/4"	13/32"	1/8" P.T.	7/16"
*1650	57/64"	3/8"	19/64"	13/32"	1/8" N.P.T.F.	7/16"
1669	1 3/4"	1 17/64"	1/4"	13/32"	1/8" P.T.	7/16"
1684	2 5/8"	2 3/16"	5/16"	13/32"	1/8" P.T.	3/8"
*1708	53/64"	23/64"	19/64"	13/32"	1/8" N.P.T.F.	11/32"
1980	41/64"	17/64"	7/32"	13/32"	1/8" P.T.	7/16"

*Leak-proof seal
†Thread size listed as 1/8" P.T. is 1/8" P.T.F.—SAE EXTRA SHORT

1/8" THREAD ANGLE HYDRAULIC FITTINGS

Part No.	A	B	C	D	E†	F	G	H
1606	1 13/16"	1"	3/8"	13/32"	1/8" P.T.	7/16"	15/32"	90°
1611	1 1/64"	17/64"	13/64"	25/64"	1/8" P.T.	7/16"	21/64"	30°
1612	53/64"	17/64"	13/64"	25/64"	1/8" P.T.	7/16"	1/2"	67½°
1613	49/64"	17/64"	13/64"	25/64"	1/8" P.T.	7/16"	33/64"	85°
1614	1 5/64"	5/16"	1/4"	13/32"	1/8" P.T.	7/16"	31/64"	105°
1620	1 5/16"	13/32"	5/16"	7/16"	1/8" P.T. (Female)	7/16"	17/32"	45°
1623	1 3/16"	9/16"	1/4"	13/32"	1/8" P.T.	7/16"	31/64"	67½°
1638	2 9/32"	1"	3/8"	13/32"	1/8" P.T.	7/16"	21/64"	30°
1649	2 25/32"	2 3/16"	5/16"	13/32"	1/8" P.T.	3/8"	29/64"	67½°
*1651	1"	3/8"	19/64"	13/32"	1/8" N.P.T.F.	7/16"	1/2"	67½°
1688	61/64"	17/64"	13/64"	25/64"	1/8" P.T.	7/16"	27/64"	45°
*1692	1 7/32"	3/8"	19/64"	13/32"	1/8" N.P.T.F.	7/16"	21/64"	30°
*1693	15/16"	3/8"	19/64"	13/32"	1/8" N.P.T.F.	7/16"	31/64"	90°
*1950	1 1/8"	3/8"	19/64"	13/32"	1/8" N.P.T.F.	7/16"	15/16"	105°

*Leak-proof seal. †Thread size listed as 1/8" P.T. is 1/8" P.T.F.—SAE EXTRA SHORT

1/4" PIPE THREAD HYDRAULIC FITTINGS

Part No.	A	B	C	D	E†	F	G	H
1627	59/64"	23/64"	9/32"	17/32"	1/4" P.T.	9/16"	......	......
1629	1"	11/32"	9/32"	17/32"	1/4" P.T.	9/16"	5/8"	67½°
1691	1 21/64"	Female Thread			1/4" P.T.	5/8"	......	......

†Thread size listed as 1/4" P.T. is 1/4" P.T.F.—SAE EXTRA SHORT.

1/4"—28 THREAD HYDRAULIC FITTINGS

Part No.	A	B	C	D	E	F	G	H
1636	31/32"	19/64"	1/4"	17/64"	1/4"-28 Taper USF-Thd.	3/8"	3/8"	45°
1637	27/32"	11/64"	1/4"	1/4"	1/4"-28 Taper USF-Thd.	3/8"	3/8"	45°
1641	31/64"	11/64"	1/4"	1/4"	1/4"-28 Taper USF-Thd.	5/16"	......	......
1652	43/64"	23/64"	1/4"	1/4"	1/4"-28 Taper USF-Thd.	5/16"	......	......
1680	59/64"	39/64"	1/4"	17/64"	1/4"-28 Taper USF-Thd.	5/16"	......	......
1698	1 7/64"	51/64"	1/4"	17/64"	1/4"-28 Taper USF-Thd.	17/64"	......	......
1703	1/2"	7/32"	3/16"	1/4"	1/4"-28 Taper USF-Thd.	17/64"	......	......
1770-A	19/32"	1/8"	7/64"	1/4"	1/4"-28 NF-2-Thd.	3/8"	25/64"	45°
1792	21/64"	9/64"	1/8"	1/4"	1/4"-28 NF-2-Thd.	17/64"	......	......
1911	47/64"	11/64"	1/4"	1/4"	1/4"-28 Taper USF-Thd.	3/8"	15/32"	90°

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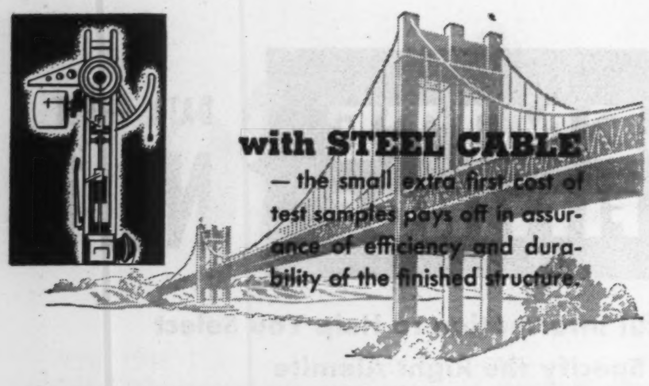

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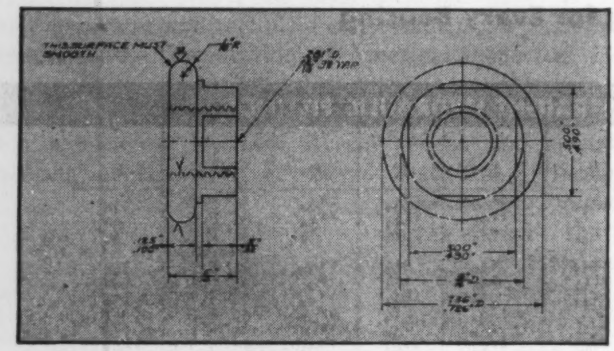
— the small extra first cost of test samples pays off in assurance of efficiency and durability of the finished structure.



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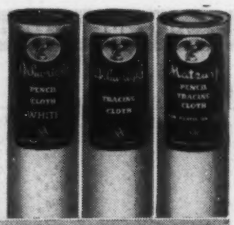

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TRACING CLOTHS

AMERICA'S STANDARD FOR OVER 25 YEARS

stitute has been announced. Dr. Kemler, who succeeds **John V. Pennington,** resigned the post of acting director of research from New York University to administer the Institute's program in Houston. He has taken over the Institute's Oil and Gas Building offices and will be active in the development of its Houston laboratory facilities. Formerly in charge of production engineering for a Gulf Oil Corp. division at Tulsa with prior research service at Westinghouse Electric Corp. and Dodge Manufacturing Corp., Dr. Kemler will be in full charge of the Houston activities of the Institute, including the establishment of a petroleum research laboratory as soon as negotiations for a site and building are completed. He earned a Doctor of Philosophy degree at the University of Pittsburgh and received engineering and master's degrees from the University of Kansas. Before going to New York University he was chairman of engineering research for Southern Research Institute at Birmingham. A member and former officer of numerous professional organizations, Dr. Kemler has authored two books, *Elements of Mechanical Vibration* and *Aircraft Vibration and Flutter.* He has supervised experimental production engineering work in the petroleum field, equipment selection and replacement research, analysis of oil well repair expense, investigations of pumping problems, and bottom hole pressure pumping, flowing and temperature studies. In addition, he has administered research programs in marine equipment, heat pumps, railroad locomotive instrumentation, vibration analysis of engines, and hydraulics.

◆

Appointment of **Ray E. Greenough** as chief engineer of the Cleveland Pneumatic Tool Co., Cleveland, has recently been announced.

◆

Frank S. Best has been named quality control engineer of Cordley & Hayes, New York water cooler manufacturer. As assistant to **S. A. Whitt,** engineering vice president, Mr. Best will be responsible for control of product quality. A graduate of Milwaukee School of Engineering, he comes to Cordley & Hayes from International Standard Electric Corp.

◆

Stephen Bianco has been appointed engineer of tests at the South San Francisco plant of Bethlehem Pacific Coast Steel Corp. succeeding **Hubert C. Swett** who has been named assistant general superintendent at the company's Los Angeles plant.

◆

Promotion of two of Alcoa's staff of research scientists has been announced by Francis C. Frary, director of Aluminum Research Laboratories at New Kensington, Pa. **Kent R. Van Horn,** chief of the Cleveland branch of Aluminum Research Laboratories since November, 1945, has been named an assistant director of research for the company. **Maurice W. Daugherty,** assistant chief of the Cleveland Laboratories during the same period, succeeds Dr. Van Horn as chief.

FOR THE FIRST TIME!

Electronic alignment of swivel table on grinding machines

HERE IS A UNIQUE AID that permits accurate alignment of swivel table for straight or tapered work after only *one* preliminary grind. ELECTRALIGN eliminates costly, time-consuming cut-and-try operations. It's an important means for avoiding spoiled work, particularly where only .002″ to .003″ is left for finish grinding.

This exclusive arrangement for Brown & Sharpe Grinding Machines uses a highly-sensitive strain gage to detect swivel table movement and an electronic amplifier to magnify movements to large scale readings. Displacements of .0001″ are easily detected. Deflections are direct reading . . . no interpolation or transposition of figures needed.

NEW, COST-SAVING ADVANTAGES

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- **Set-up time sharply reduced.**
- **Easier operation, faster production on work ground to close limits.**
- **Continuous, visual check.**

ELECTRALIGN

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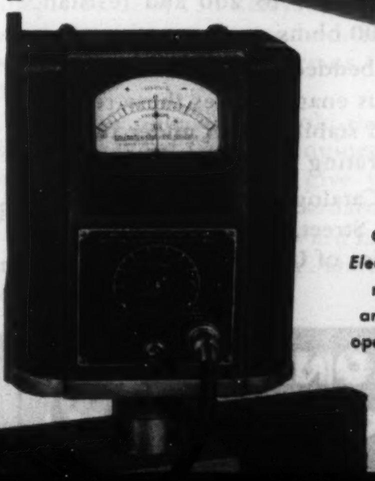
The following Brown & Sharpe Machines are obtainable with ELECTRALIGN: Nos. 1, 2, 3, and 4 *Universal*—No. 5 *Plain* (3″ x 12″ and 3″ x 18″)—No. 10 *Plain* (6″ x 18″ and 10″ x 18″)—No. 12 *Plain* (6″ x 30″ and 10″ x 30″)—No. 20 *Plain* (10″ x 18″)—No. 22 *Plain* (10″ x 36″)— No. 23 *Plain* (10″ x 48″)—No. 13 *Universal and Tool.* Write for illustrated Bulletin. Brown & Sharpe Mfg. Co., Providence 1, R. I., U.S.A.



Conveniently located amplifier of the *Electralign* magnifies small angular table movements to large scale readings. Shows any shift in table setting during grinding operation. Permits correction at any time during operation.

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Assets to a Bookcase

Quality Control

By Norbert L. Enrick, associate professor of management, Louisiana State College; published by The Industrial Press, New York; 122 pages, 6 by 9¼ inches, clothbound; available through MACHINE DESIGN, *$3.00 postpaid.*

A practical and usable book on a subject too often not well enough understood by machine designers and engineers in general. Personnel responsible for designing and producing uniform quality products to specified standards at minimum costs should know, for instance, the basis for proper specifications; i.e., practical and workable tolerances established should be supported by both technical and statistical considerations. This book includes chapters on sampling plans, sample control charts, compressed limit gages for mass-manufactured products, special control charts for use when equipment is old or worn, and tolerances and allowances in interchangeable manufacture. All material presented is based on scientific methods which have proven themselves in press working, machining, assembling, plating and polishing, and other production operations.

□ □ □

Patent Law

By Chester H. Biesterfeld, attorney with patent department of E. I. du Pont de Nemours & Company Inc., published by John Wiley & Sons Inc., New York; 267 pages, 6 by 9 inches, clothbound; available through MACHINE DESIGN, *$4.00 postpaid.*

Continued advance in design and development is in great measure a result of adequate recognition and compensation of the designer's contribution. Of importance to both the engineer and engineering management is a thorough knowledge of those laws which protect the "reward motive". These laws, although far less changing than design, are, nevertheless, subject to continually varying interpretations. An understanding of such changes due to legislative and judicial decisions is vital. With this in mind, the author has prepared a second edition to his book.

As in the first edition, this book presents the basic principles of substantive law in easily understandable terms. Originality, priority of invention, functional claims, double patenting, patent application, interferences, infringement, patent litigation, and other aspects are informatively set forth. A careful selection from leading decisions to substantiate the various principles is included.

The revisions in the second edition have been extensive. To be in accord with the modern ideas of the courts on the subject of invention, the author has inserted recent decisions. The chapters "Uses", "Double Patenting", and "Disclaimer" have been redrafted to comply with the latest views. An extensive insert into the chapter dealing with infringements presents the Supreme Court cases on the interpretation of patent claims. Abolition of recovery of profits in 1946 made advisable the omission of the discussion of profits; that of damages is given in greater detail. "Trade Secrets" has been expanded to include a discussion of alleged right in ideas, and the doctrine of "nonfunctional" features.

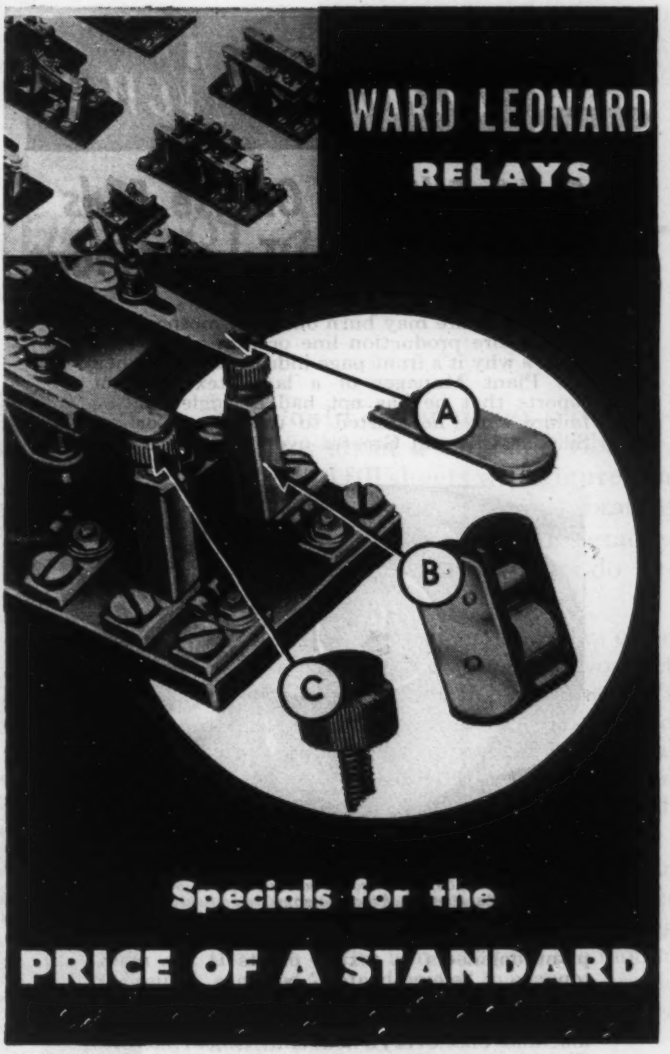
This is a presentation of patent law in all its phases from its inception to the modern time. The intricate weave of law writing is supplanted by terms more generally understandable by engineers and inventors.

Previously issued separately as National Bureau of Standards handbooks H31 through H35, the first five parts of the fifth edition of the *National Electrical Safety Code* are now published in one volume. Installation and maintenance rules for electric supply stations, communication lines and electric utilization equipment are given along with safety rules for the operation of electric equipment and a section on radio installation. The 408-page, clothbound book, NBS handbook H30, may be obtained from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. for $1.25.

A dictionary of German electrical symbols originally published for United States military use is now available from the Office of Technical Services. It comprises approximately 1200 symbols used to designate components of German communications systems. Each symbol is identified according to conventional American designation. Samples of various types of communications setups and line route networks are presented. The 120-page dictionary is available as report PB-85121 from the Office of Technical Service, Department of Commerce, Washington 25, D. C., for $3.00.

American Standard Letter Symbols for Physics, has been published by the American Standards Association. Symbols for all common terms in elementary physics and some in advanced physics and related fields are included. The 37-page booklet, Z 10.6—1948, is available from the American Standards Association, 70 E. 45 St., New York 17, N. Y. for $1.00.

Presented by the Aluminum Co. of America, a 188-page book, *Designing For Alcoa Die Castings*, is an accumulation of information on aluminum and magnesium diecasting practice. It outlines basic principles of interest to the designer or buyer of light-metal diecastings. Data on the casting process and equipment, alloys, and design rules, and brief discussions on machining and finishing of diecastings are included. The 5½ by 8½ inch, clothbound book is available from the company at the Gulf Building, Pittsburgh 19, Pa. for $1.00.



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DC Silicone News

DC 44 Silicone Grease Ends Bearing Failure in Textile Plant

Bearing failure may burn out your motors, stop your entire production line or ruin a mill run. That's why it's front page industrial news when the Plant Manager of a large textile plant reports that he has not had a single bearing failure since he started to use Dow Corning Silicone Oils and Greases over 30 months ago.

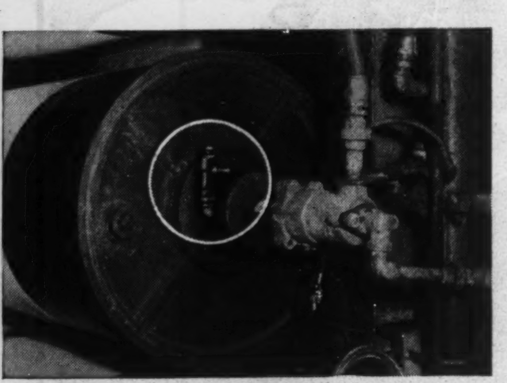

PHOTO COURTESY AMERICAN FINISHING COMPANY

DC 44 Silicone Grease in ball bearings on drying cans, operating at 400 r.p.m. around saturated steam journals, has 45 times the life of the organic grease previously used.

Typical of the lubrication problems that plague plant engineers in textile plants is the maintenance of "steam-heated" bearings. It used to be necessary to lubricate bearings on drying cans and the main cylinder bearings of Sanforizing machines once every 8 hour shift. Since American Finishing started to use DC 44, the re-lubrication schedule has been cut to once every 30 to 45 shifts. The lubrication of Slashers on textile mills presented a similar problem that has also been solved by using DC 44.

On tenter frame chains and races that travel through ovens at 400°F., petroleum oils carbonized so rapidly that the chains had to be cleaned periodically. That costly operation and the need for continuous lubrication have been eliminated by a weekly application of DC 710R Silicone Fluid.

American Finishing, like many other skillfully engineered companies, has found that Dow Corning Silicone lubricants more than pay for themselves in reduced maintenance costs. Increased production due to the virtual elimination of bearing failure is another one of the many bonuses Dow Corning Silicones pay to modern industry. For the most recent data on DC Silicone Greases phone our nearest branch office or write for data sheet No. D5P.

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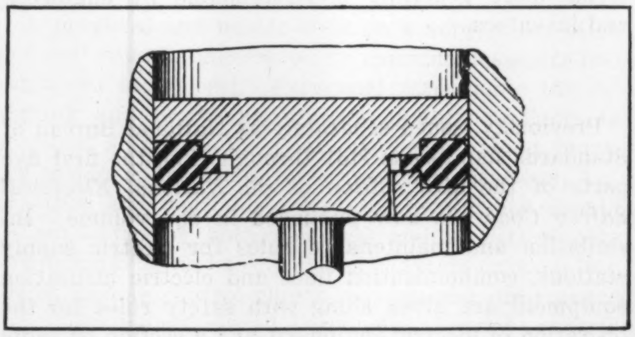
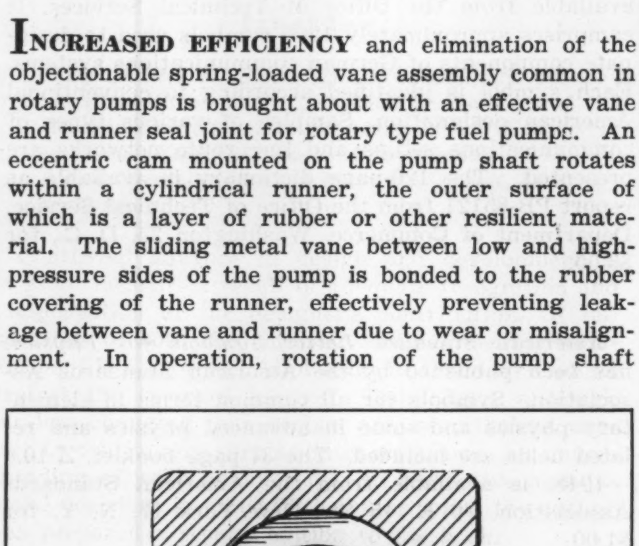
Dow Corning
FIRST IN SILICONES

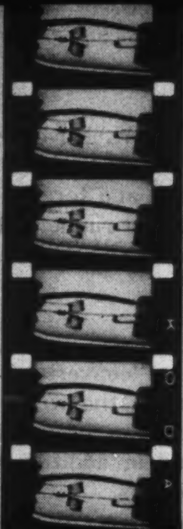
Noteworthy Patents

IMPROVED SEALING between reciprocating machine elements, such as pistons and cylinders, is accomplished with a new groove design for O-rings covered in patent 2,462,596. Pressure on the seal ring, as in a hydraulic cylinder, causes the ring to be compressed into an annular recess in the bottom of the ring groove, preventing side flow and resultant increased friction between the ring and the cylinder wall. The annular recess also prevents the seal ring from rolling in its groove, eliminating excess ring wear and decreasing cylinder wall friction. Arthur J. Bent has assigned the patent to Westinghouse Air Brake Co.

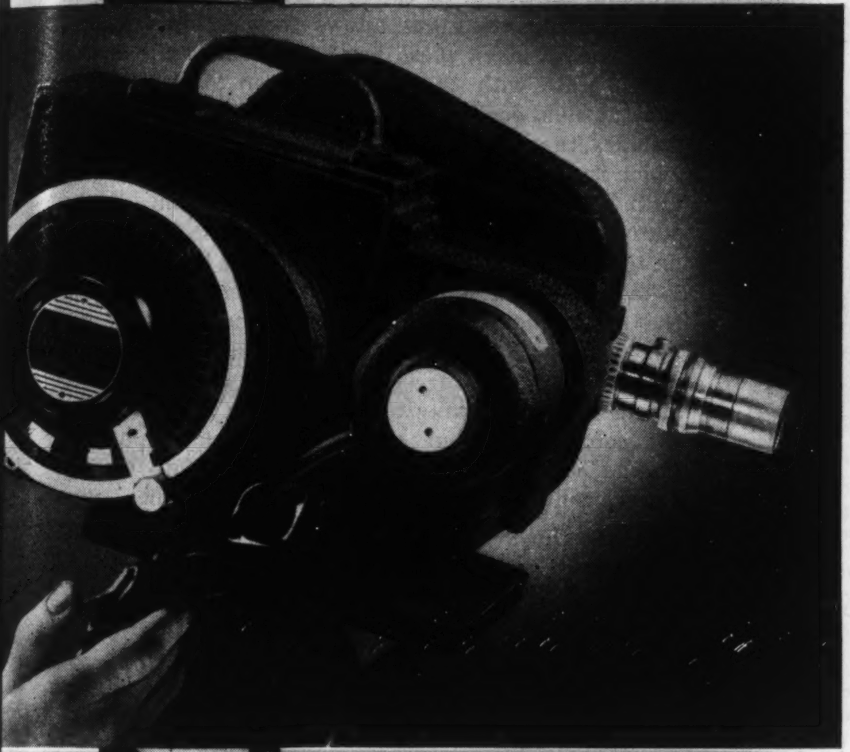


INCREASED EFFICIENCY and elimination of the objectionable spring-loaded vane assembly common in rotary pumps is brought about with an effective vane and runner seal joint for rotary type fuel pumps. An eccentric cam mounted on the pump shaft rotates within a cylindrical runner, the outer surface of which is a layer of rubber or other resilient material. The sliding metal vane between low and high-pressure sides of the pump is bonded to the rubber covering of the runner, effectively preventing leakage between vane and runner due to wear or misalignment. In operation, rotation of the pump shaft





It can show you the heartbeat of a car radio—



You could cover pages with calculations about a car radio vibrator. You could fill sheets with figures on inertia and elasticity of its vibrating elements—and yet not be sure exactly how the rapidly moving parts do behave in action.

This is where high speed movies come in—the kind of "slow motion" you get from the Kodak High Speed Camera. It's a simple, direct means to record and study high speed repetitive mechanical motion . . . the only way to see dynamically what happens in non-cyclic high speed action.

The Kodak High Speed Camera can take a second of action and spread it over three minutes. It can put flash marks along the side of the film that time the motion accurately. Its optical system gives the extra picture sharpness you need to see a vital point clearly.

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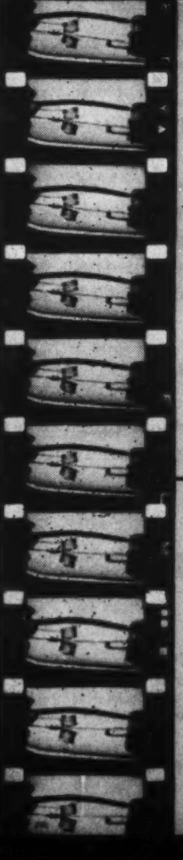

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causes the eccentric cam to roll the rubber-covered runner around the pump housing, reciprocating the sliding vane in its slot in the housing and forcing the fluid from inlet to outlet ahead of the runner. Roy O. Balogh has assigned the patent, No. 2,460,617, to the Weatherhead Co.

ONE-WAY LOCKING for torque converters described in patent 2,461,217 eliminates the wear and brinelling of bearing surfaces common in previous roller-bearing one-way clutches and in addition provides a positive lock-up at low speeds. The clutch prevents the stator of the converter from rotating in a reverse direction but allows forward rotation so that when a given speed has been reached the stator can operate with the rotor member to provide, in effect, a fluid coupling. In construction, the assembly includes the stator mounted on a stationary sleeve, which is fixed to the transmission housing, and a dog-tooth clutch incorporated between the hub of the stator and the sleeve. A toothed member is mounted on the sleeve for sliding movement on a helical spline. When the stator is rotating in the same direction as the rotor, the sliding member is moved out of engagement with its mating toothed surface, allowing the stator to rotate freely. However, when the stator starts to turn opposite to the direction of rotation of the rotor, the sliding member moves longitudinally on the helical splines of the sleeve and into locking engagement with the second toothed member, thus locking the stator against reverse rotation. Robert Lapsley and Burton L. Mills have assigned the patent to Clark Equipment Co.

Cam Design and Application

(*Concluded from Page* 111)

eration changes. For cams with a single dwell period a combination of cycloidal and parabolic contours provides a suitable solution. The full lines of *Fig.* 22 show the acceleration, velocity, and displacement characteristics of this contour. The dotted lines present the results for a cycloidal contour.[3] The requirement for gradual changes in acceleration can of course be met by other contours. Combinations of the cubic and parabolic follower motions are often used, *Fig.* 23. Dudley has proposed that the ideal motion is one in which the output motion, x, results in a minimum value of

$$\int_0^{\theta_0} (d^2x/d\theta^2)^2 d\theta$$

Part III of this three-part series of articles will discuss the design of cam followers and follower systems.

REFERENCES

1. "An Analysis of the Dynamic Forces in a Cam Driven System"—J. A. Hrones, *Trans. ASME,* Vol. 70, No. 5, July, 1948.
2. "New Methods in Valve Gear Design"—W. M. Dudley, *Quarterly Trans. SAE,* Vol. 2, No. 1, Jan. 1948.
3. Discussion of Ref. 1, by W. F. Huck.

GENERAL REFERENCES

"Poppet Valve Dynamics"—E. H. Olmstead and E. S. Taylor, *Journal of Aeronautical Sciences,* Vol. 6, 1938-39.
Valve Gear Design—M. C. Turkish, Eaton Mfg. Co., Detroit.

Production of new TIMKEN® "OO" bearing being increased to meet demand!

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Only a few short months ago, The Timken Roller Bearing Company announced a new bearing—the "Double-Zero"—*twice as accurate* as any Timken® bearing previously produced.

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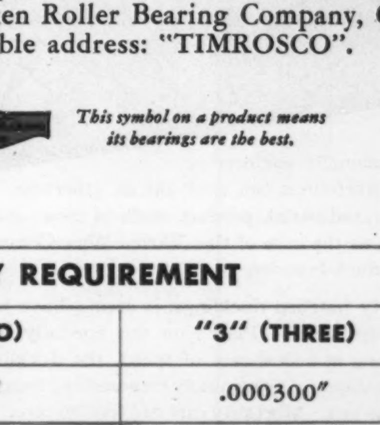

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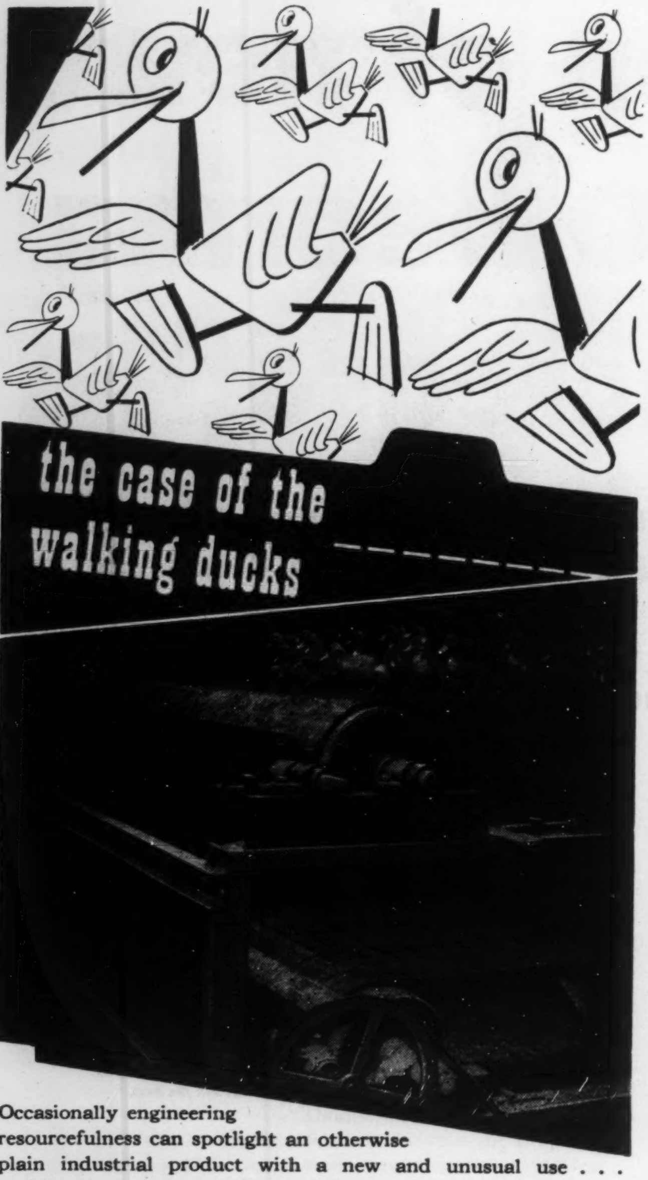

the case of the walking ducks

Occasionally engineering resourcefulness can spotlight an otherwise plain industrial product with a new and unusual use . . . such as the case of this Woven Wire Conveyor Belt installation in a duck brooder.

Newly hatched ducklings, it seems, have to be kept moving to be kept alive. Placed on this specially built woven wire belt moving at a slow rate of speed, the ducklings remain there for eight days . . . continually treadmilling away from the falling end of the belt. Mortality rate dropped to zero. By-product recovery . . . duck droppings for fertilizer . . . is aided by the open mesh of the woven wire belt.

Even if you don't operate a duck hatchery, call in a Cambridge engineer whenever you have a problem concerning the movement of materials or products during processing. Let him explain the superior construction features of . . .

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Powder-Metal Parts

(Continued from Page 136)

7. Readily obtainable homogeneity of compacts free from the voids and gas pockets common in cast parts. Because of their homogeneity, sintered parts produced under conditions yielding comparatively low physical strength can often replace cast parts theoretically having several times the strength
8. Elimination of trimming cost which in diecast parts often exceeds the cost of the casting itself, and of scrap which in small machined and stamped parts may exceed the weight of the finished article.

Tooling for simple pressed powder-metal pieces requiring single punches at top and bottom, with or without core pins, seldom presents any problem other than educating the designers and toolmakers in the importance of close fits, mirror finishes and avoidance of drafts and fillets which allow powder to wedge between moving parts. Generally, production of such tools is faster and cheaper than that of multiple-cavity diecasting dies of equal productivity.

Fig. 9 illustrates the comparative complexity of two sets of tools of equivalent productivity. Cost of the powder-metal tool is approximately $500; that of the diecasting die, $2,500. The material for the tool is determined by the length of the run. Over 250,000 iron parts of the nature illustrated can be produced on an average from tool-steel dies, before dressing, chrome plating or replacement of one or more components of the tool is necessary. Normally two such repairs are possible before excessive burr or change in dimensions throws the part out of specified tolerance. Incidentally, it is a special characteristic of powder metal tools that excessive wear becomes apparent by visual inspection of the piece itself.

When production runs of millions of pieces are involved, tungsten carbide dies will more than pay for themselves. At Lionel we make extensive use of carbide for dies, punches, and even core pins with excellent results. Careful attention must be given to the method of holding the carbide facing or tip to the tool-steel shanks, as the high compacting pressures will at times break down an apparently perfect brazed joint. Best results have been achieved by eliminating brazing entirely and retaining tungsten carbide punch facings within the steel shank by shrink or press fit. Mechanical clamping of the lower punch, shown in *Fig.* 10, is still in the experimental stage.

Tooling Often Complicated

While simple pieces present little tooling difficulty, the more complex parts which require sectional punches or present special ejection problems tell a far different tale. The powder metal process is relatively so new that no set tooling technology as in stamping or diecasting has yet been developed. This fluidity is evidenced in the radically different concepts of tool construction which will frequently be suggested for the same part by competent authori-

Arc Welding of Pumps Cuts Weight 56%

By E. L. Alexander, Chief Engineer
George E. Failing Supply Company
Enid, Oklahoma

Fig. 1. Saves 825 pounds *by using welded steel construction on mud slush pump. Simple fixture is used to position parts with close fit-up for speedy welding.*

THROUGH the use of arc welded construction, the weight of our pump unit has been reduced from 1,475 pounds to 650 pounds. This saving of 825 pounds is important since the drilling unit on which the pump is used must be highly mobile. The drills are used for oil exploration work and for water well drilling. The pumps are designed for operation at 375 psi. The arc welded construction has eliminated sand holes, surface blemishes, and uneven metal distribution in cast parts. A recent cost analysis indicates the pumps will be produced at a saving.

The development of our all welded pump is typical of the general trend in the oil industry toward all welded machines and equipment. As a result of the greater durability to withstand severe service, many customers show a decided preference for arc welded steel construction.

Important to us also is the freedom for future design improvements and further cost reductions possible with arc welded construction. By discarding patterns and castings, we eliminate many of the cost restrictions that would otherwise limit progressive design changes in our products.

Component parts for our welded pumps are fabricated from flame-cut mild steel plate and from SAE 1020 cold drawn tubing. The two main units are the mud end shown in Fig. 2 and the power end shown in Fig. 3. These units are first fabricated as sub-assemblies in separate jigs and then arc welded in master jigs with "Fleetweld 5" electrode, using Lincoln "Shield-Arc" welders.

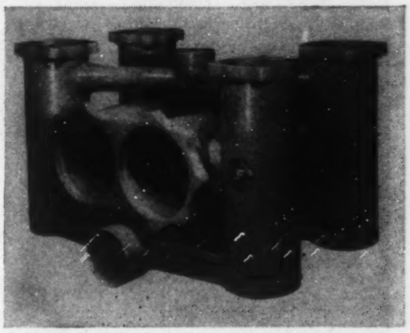

Fig. 2. Mud End Assembly. *Parts are fabricated from SAE 1020 cold drawn steel tubing with 3/16" wall thickness; flanges are flame-cut from 7/8" plate. Welds are 1/4" or 3/8", single and multiple pass, depending on the joint preparation.*

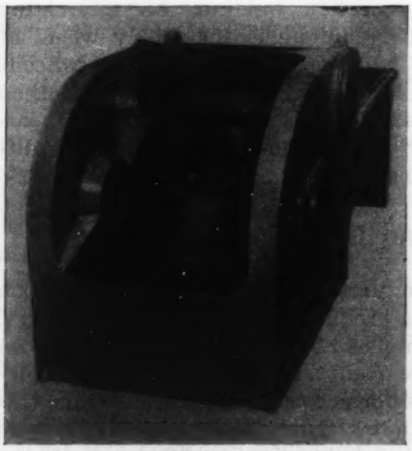

Fig. 3. Power End Housing. *Walls are flame-cut from 3/16" steel plate. Bosses are machined from steel tubing and fillet welded to wall with 1/8" "Fleetweld 5" electrode.*

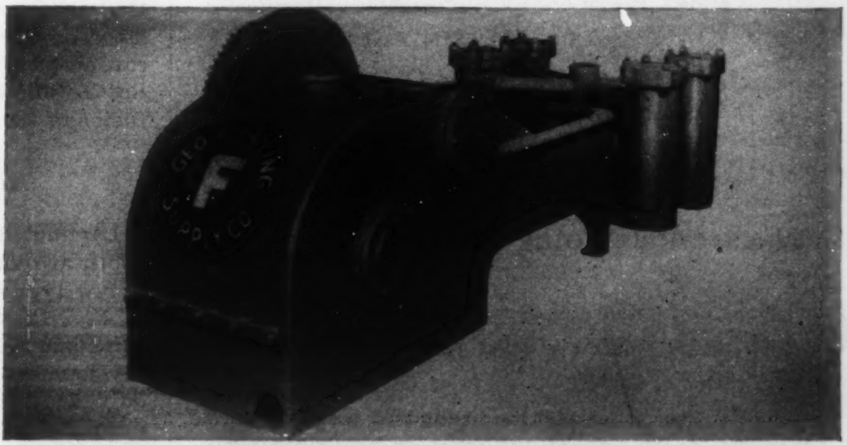

Fig. 4. All Welded Steel Pump *for well drilling operations. Light in weight and easy to move around . . . has corners rounded for "modern" appearance.*

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If the performance of your product depends on precision timing, consult Cramer. As specialists in TIME as a factor of CONTROL, we have developed a wide range of devices to meet the needs of a great variety of commercial and industrial applications. Send today for detailed information.

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Box #6, Centerbrook, Conn.

2CR49

ties in the field.

Although complex pieces can be successfully pressed in temporary tools by alternate shimming and pressing of the separate punches, production tools freqently present a vexing problem that may well stump an average tool designer. Pieces requiring independent motion of various punches are properly made in multiple-ram machines which are generally to be found at the better equipped custom fabricators, but the cost of which—$25,000 and up—is seldom economically justified for in-plant production. It is true that such multiple action can be simulated (when the die is clean) by an assortment of springs, cams, catches, etc., but these complex tools require careful watching for the first sign of drag which will result in varying fill and widely varying dimensions. In many cases it would be well to remember that discretion is the better part of valor and to turn over the tooling and production to a competent custom fabricator, who will have invested a small fortune in multiple-action presses.

Generally speaking, we have found that in comparison with most stamping or diecasting tools, which produce satisfactory parts almost from the outset, complex powder-metal tools require a much greater lead time. The reason for this lies partly in the inherent lack of plastic flow of metal powder requiring experimental adjustment of the tools, and partly in the lack of flexibility of the present-day presses.

As insurance against unforeseen delays in the perfection of production technique for complex parts, we have upon occasion tooled up for an alternate method of fabrication—particularly when faced with a tight production schedule.

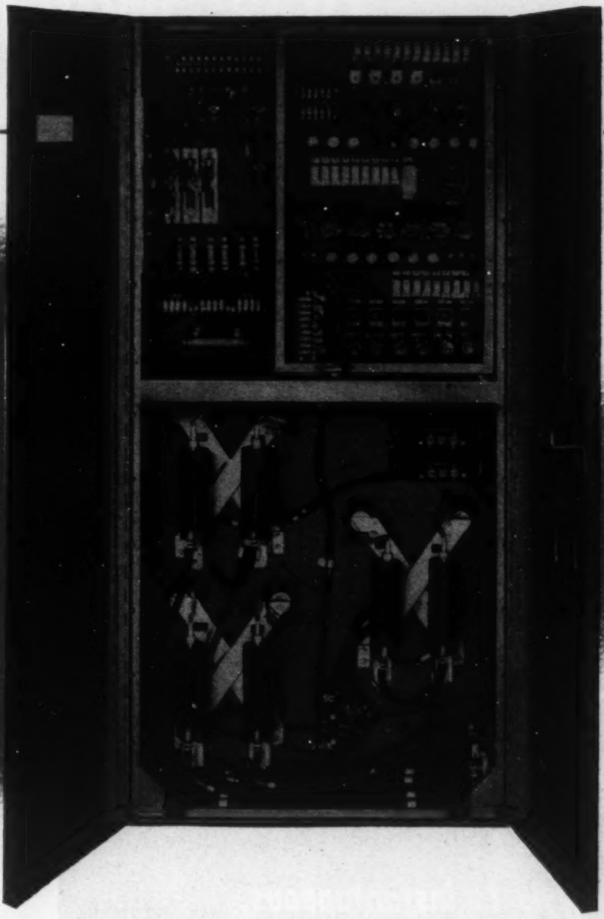
A case in point is the geared wheel shown in *Fig.* 11. Because of the complexity of the problem presented by pressing a flange in the middle of the piece in addition to the gear on one face and a rather complex surface detail on the other, interim diecasting tools are provided. Another solution which has since been developed for this and similar parts, shown in *Fig.* 11, is assembly of two relatively simple powder-metal parts by projection welding. An interesting application of this technique is the pulley wheel at the right made by welding together two car wheels. Experiments on brazing indicate that this method can also be used successfully if high-frequency heating is followed by a rapid quench to arrest the diffusion of the brazing material.

Laminates Offer Opportunities

Laminated structures because of their uniform depth are ideal for production by powder metallurgy. A few typical examples of such structures are shown in *Fig.* 12. On the right are recently-developed machine-stacked transformer core elements. While this development eliminates much hand labor it does so only at the cost of increasing to 32 per cent the normally insignificant amount of transformer lamination scrap. At the left are field and armature structures for small ac motors. The scrap loss in blanking laminations is 46 per cent. In making use of the pressing technique, the pole faces would be expanded to increase the area at the air gap and thus mate-

YOU CAN BE **SURE**.. IF IT'S

Westinghouse



For your Resistance Welding Applications

NOW...

a 3-PHASE CONTROL

cuts kva demand in half

Here's a new, cost-cutting answer to resistance welding problems caused by power use restrictions, excessive power costs or poor weld quality. It's the Westinghouse 3-phase, low-frequency welding control that cuts kva demand in half, while providing good welds on all types of metals.

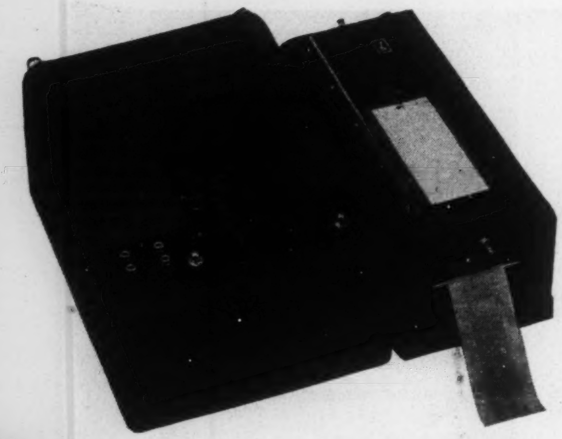
Rusty or scaly steels, aluminum, brass and steel alloys join easily and the job goes smoothly because there's less tip pickup . . . less spitting at the electrodes. This is because the control, which is designed to spread kva over the three phases, distributes the load and provides for a smooth flow of heat into the metal. Kva demand is less because of the reduction of secondary reactance that accompanies operation at lower frequencies.

This is a complete packaged unit that controls all mechanical and, electrical functions for the welding machine. It can be mounted on the floor or on the side of the machine. A swing-out panel provides easy access to all components and circuits. It can be applied to existing installations by changing the welding machine transformer.

For complete details, see your Westinghouse representative, or your local resistance welding machinery agent. Ask for B-4341. Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh, Pa. J-60718

Westinghouse

ELECTRONIC CONTROL



The Brush Single-Channel Oscillograph with Carrier Amplifier, Model BL-310. Oscillographs available in Double and Six-Channel units also.

Strain©

analysis is instantaneous, permanent, and accurate with the "Strain Analyzer"

Designed for use with wire strain gages or other resistance elements. Two "Strain Analyzer" models are available, which, with suitable pickups, give immediate records of strains, pressures, temperatures, torques, vibrations or accelerations. Either static or dynamic phenomena up to 100 c.p.s. may be recorded.

Investigate Brush measuring devices before you buy . . . they offer more for your money.

Write today for detailed information on this equipment.

THE Brush DEVELOPMENT CO.
3405 Perkins Avenue • Cleveland 14, Ohio, U. S. A.
MAGNETIC RECORDING DIV. • ACOUSTIC PROD. DIV.
INDUSTRIAL INSTRUMENTS DIV. • CRYSTAL DIVISION

Canadian Representatives:
A. C. Wickman (Canada) Ltd., P. O. Box 9, Station N, Toronto 14

rially increase the efficiency of the magnetic circuit.

Powder metallurgy has already become an indispensable tool in a specialized but constantly growing field of applications and, if given a fair chance to grow and expand, will become an invaluable weapon in the constant struggle to make more and better things available to an ever greater number of people—which purpose after all, is the fundamental goal of society in general and of the engineering profession in particular.

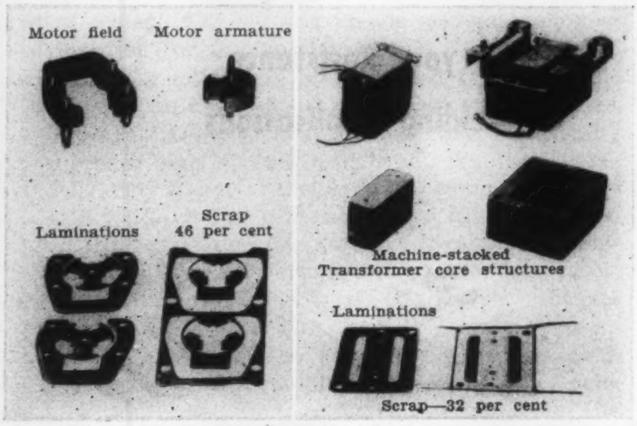


Fig. 12—Motor field and armature laminations, now stamped from sheet or strip stock as shown here, could be produced as powder-metal compacts at considerable saving in scrap. Also, powder metallurgy would permit redesign to step up the efficiency of the units

---

Engineering Graduate

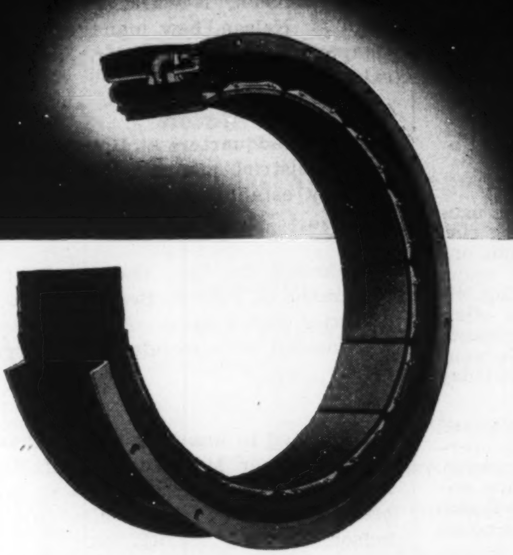
(*Concluded from Page* 126)

just anxious. You will not have to rigidly commit yourself, but a general overall picture will answer many of the questions that are in his mind and tend to allay his dissatisfaction over the apparent lack of rapid promotion.

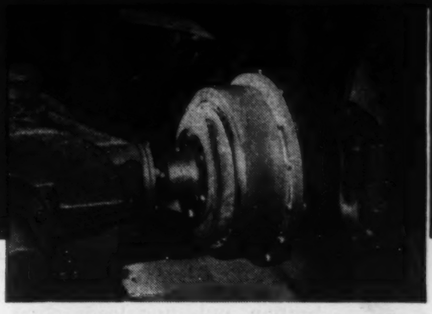
You should make it clear how you expect him to prepare for such advancement. He has been taught to expect that he will have to do considerable further study. You can, as you watch him, suggest the material about which he should gain a fuller knowledge. It might even be wise to make the time for such study available. In the case where graduate study leading to an advance degree is necessary, a suitable leave of absence should be arranged. And if you are afraid he may not come back to you, then you have not done your part of the job correctly. If your organization is large enough you should indulge in what are known as inservice courses in management, personnel problems and the special technical phases of your work. You should also encourage him to get out and meet engineers of other companies. See that he joins and participates in the junior groups of the professional societies.

ONLY ONE MOVING PART

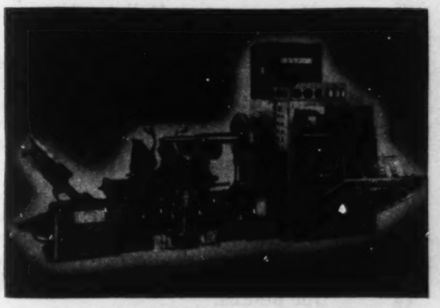
in this Fawick Clutch



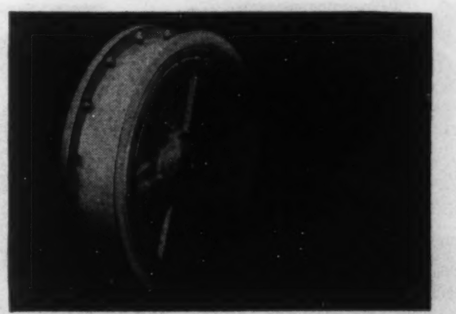
Fawick Airflex Clutch or Brake Type CB



Fawick Airflex element used on Suction Press Drive at Crane & Co., Inc., Dalton, Mass.



Fawick Airflex element used on Passenger Tire Building Machine by National Rubber Machinery Co., Columbiana, Ohio.



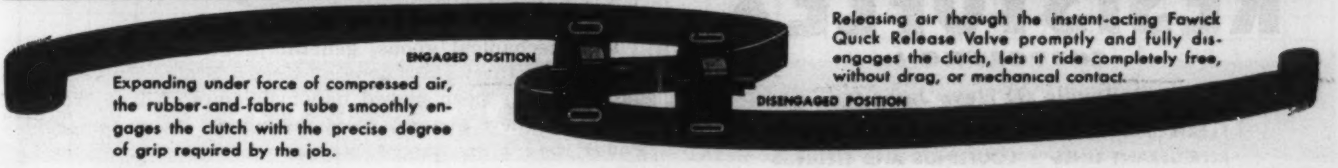
Fawick Airflex element used on Draw Bench at Penn Brass & Copper Co., Erie, Pa.

The rubber-and-fabric pneumatic tube faced with friction shoe assemblies is the only moving part in this Fawick Clutch. This part naturally stays in perfect adjustment at all times—automatically compensating for wear of the friction shoes.

Job-tested, Fawick Clutches meet the toughest operating conditions in many fields—petroleum, earth-moving, metalworking, rubber, paper, pulp and others.

Write our engineering department for a recommendation of the Fawick elements best suited for your machines. Address Dept. MD.

FAWICK Airflex CO., INC.



Expanding under force of compressed air, the rubber-and-fabric tube smoothly engages the clutch with the precise degree of grip required by the job.

Releasing air through the instant-acting Fawick Quick Release Valve promptly and fully disengages the clutch, lets it ride completely free, without drag, or mechanical contact.

When you equip with
RESISTOFLEX ASSEMBLIES
you can
FORGET YOUR
HOSE PROBLEMS

The best hose you can buy is usually the cheapest in the long run. For a top grade hose stands up. It keeps fluid or gas flow under complete control despite constant flexing, vibration, pulsating loads. Such a hose offers greater security against costly replacements, circuit troubles, customer complaints. No wonder so many well-known manufacturers today rely on Resistoflex assemblies!

Four Resistoflex lines, for example, are used in the lubrication circuit of the smoothly operating Reeves Variable Speed Transmission. Even where temperature extremes are encountered, these lines have proved they'll *stay* flexible, and withstand a tremendous amount of flexing.

Why not play safe with Resistoflex quality in your own applications? "Line up" with these long-lasting, leakproof assemblies that are impervious to hydraulic fluids, oils, gases. Write for details.

Lubrication system of the Reeves enclosed design Variable Speed Transmission with its four Resistoflex assemblies.

RESISTOFLEX
CORPORATION
Belleville 9, New Jersey
FLEXIBLE HYDRAULIC, OIL, GAS, VACUUM AND
REFRIGERANT LINES • COUPLINGS AND FITTINGS

Sales Personnel

WOLVERINE TUBE DIVISION of Calumet and Hecla Consolidated Copper Co., Detroit, announces the promotion of J. L. Young Jr. to manager of Southwestern sales. Mr. Young, with headquarters in the Houston office, is in charge of Wolverine sales in Texas, Arkansas, Louisiana and Oklahoma and supervises operation of the company's Mill Depot, 1515 Fulton St., Houston, Tex.

◆

Announcement has been made by the Westinghouse meter division, Newark, N. J., of the appointment of John M. Nelson, new manager of meter sales, and J. F. Chapman who succeeds Mr. Nelson as manager of relay sales.

◆

With headquarters at Houston, D. L. Coleman has been named district manager for Ampco Metal Inc. in their recently established Eastern-Texas division.

◆

Redmond Co. Inc., Owosso, Mich., announces the appointment of Paul B. Best Jr. as vice-president in charge of series motor sales. At the same time, James Tweedy was named vice-president in charge of induction motor sales.

◆

Promoted to manager of the Kansas City branch office of the Berger Mfg. Division of Republic Steel Corp. is John E. Ellas, whose position as salesman in the Detroit branch office has been filled by Richard E. Lautzenheiser.

◆

Goodyear Tire & Rubber Co. has recently appointed M. W. Sledge to the position of assistant manager of their belting sales department. Mr. Sledge has been a salesman for Goodyear since 1938.

◆

According to a recent announcement, Edmund Pfeifer is the new assistant district manager of sales of the Boston, Mass. office of the Lukens Steel Co. He will assist H. G. Austin, who will continue as manager of sales. At the same time Charles H. Pyle took over the territory formerly handled by Pfeifer and will continue to operate out of the Coatesville, Pa. district sales office.

◆

The W. A. Jones Foundry and Machine Co., Chicago, has recently named Joseph A. Marland sales manager and Thomas A. Jones assistant sales manager.

◆

Formerly director of the laboratory development section of the magnesium laboratory of Dow Chemical Co., William S. Loose has been appointed magnesium division sales manager. Mr. Loose has been associated with magnesium operations of the company since 1927.

◆

The mechanical goods, general products, Lastex yarn and rubber thread divisions of United States Rubber Co. have recently been placed under the direction of Walter F. Spoerl, new general sales manager. Also, James E. Power has been named manager of national accounts

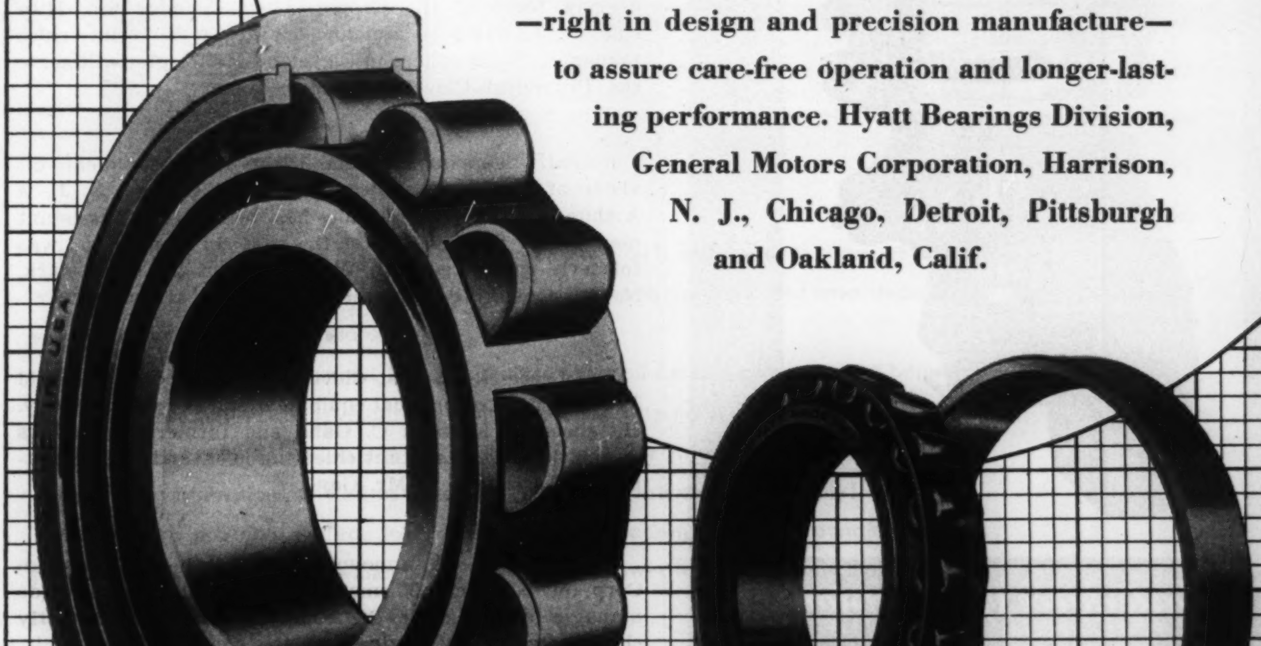
HYATT...Always as new as next month

Hyatt invented the roller bearing fifty-seven years ago.

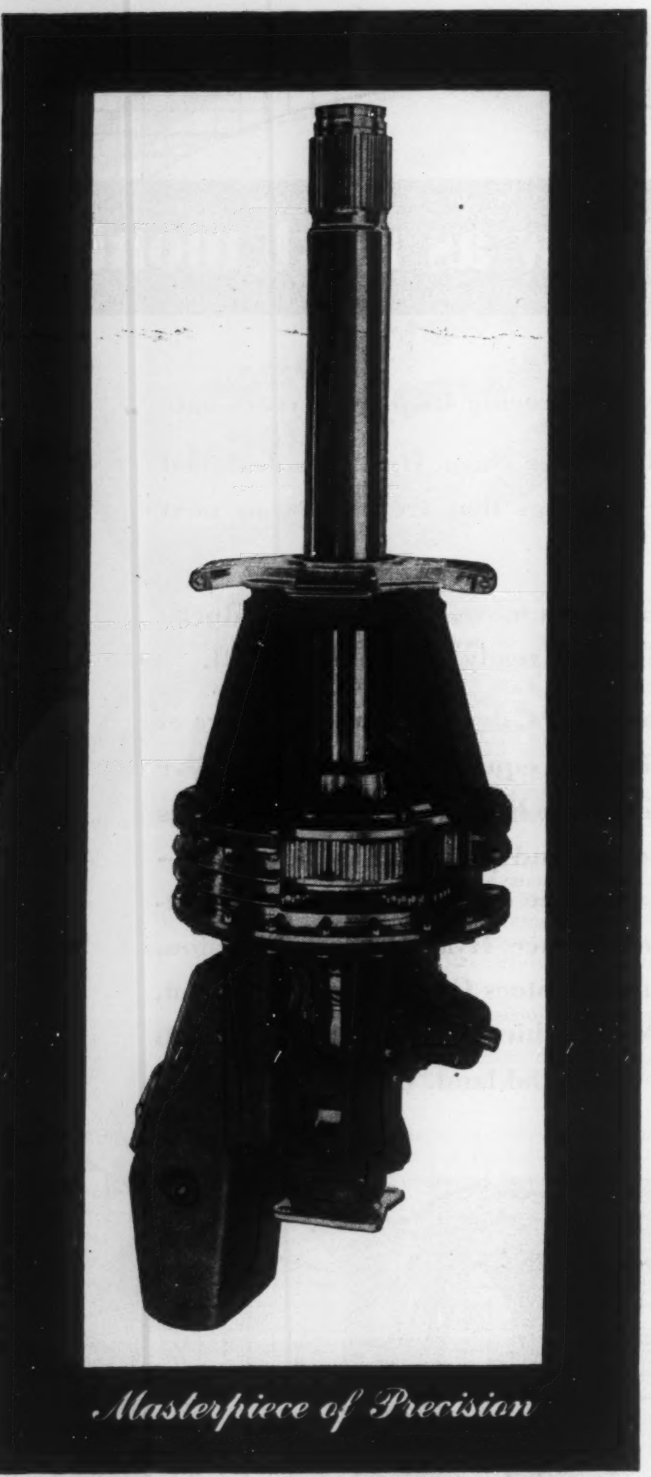
Here at the birthplace, ever since, Hyatt has designed and produced roller bearings that are as new as next month.

As fast as design-engineers moved on to new products, a newer, better bearing was ready for them at Hyatt.

So during these many years, designers and builders of every type of machine or equipment requiring roller bearings have looked to Hyatt for the right bearings—right in design and precision manufacture—to assure care-free operation and longer-lasting performance. Hyatt Bearings Division, General Motors Corporation, Harrison, N. J., Chicago, Detroit, Pittsburgh and Oakland, Calif.



HYATT ROLLER BEARINGS



450 H.P. main gear box of approximately 12 to 1 reduction for the Sikorsky S-51 Helicopter.

Fabricated in its entirety by IGW's skilled craftsmen.

Indiana GEARS

GEARS • CAMS • INTRICATE AND PRECISE MACHINE PARTS

INDIANA GEAR WORKS • INDIANAPOLIS 7, IND.

sales for the mechanical goods division, and W. A. Tipton was appointed manager of branch sales for the division. O. S. True is the new district sales manager for the division's New York branch.

◆

Industrial designer Carl Otto has recently opened his own design offices in New York. Mr. Otto was formerly head of the product design division of Raymond Loewy Associates.

◆

Announcement has been made of the appointment of Albert M. Baehr as Ohio sales representative of C. P. Clare & Co. Offices are located at 11621 Detroit Ave., Cleveland 2, O.

◆

A branch sales office, headed by W. M. Reese, has been opened by Cutler-Hammer Inc. at 155 Washington St., Newark, N. J. This company's Columbus office, directed by R. D. Yoder, has moved to 2700 East Main St., and the Youngstown branch is now located at 25 East Boardman St., under the direction of E. J. Gove.

◆

With headquarters in Philadelphia, Howard W. Stephens has joined the eastern sales organization of the Cold Metal Products Co., Youngstown, O. Mr. Stephens was formerly associated with Wheeling Steel Corp.

◆

Appointment of James E. Ziegler to the sales engineering force of the Cooper Alloy Foundry Co., Hillside, N. J., has been announced by Jack Victorine, sales manager. With offices in Cleveland Mr. Ziegler will serve the Pittsburgh-Cleveland-Detroit areas.

◆

Recently appointed manager of the instrument division of Thomas A. Edison Inc., West Orange, N. J., is Arthur A. Blue. Mr. Blue has been acting assistant manager of the division for the past six months and was formerly associated with W. W. Slocum & Co., Newark, N. J., consulting engineers.

◆

The Leece-Neville Co., Cleveland, has appointed Harold J. Zuske head of original equipment sales of the company. He succeeds Kenneth C. Gano and formerly served as design engineer, assistant chief engineer, and sales manager and assistant to Mr. Gano.

◆

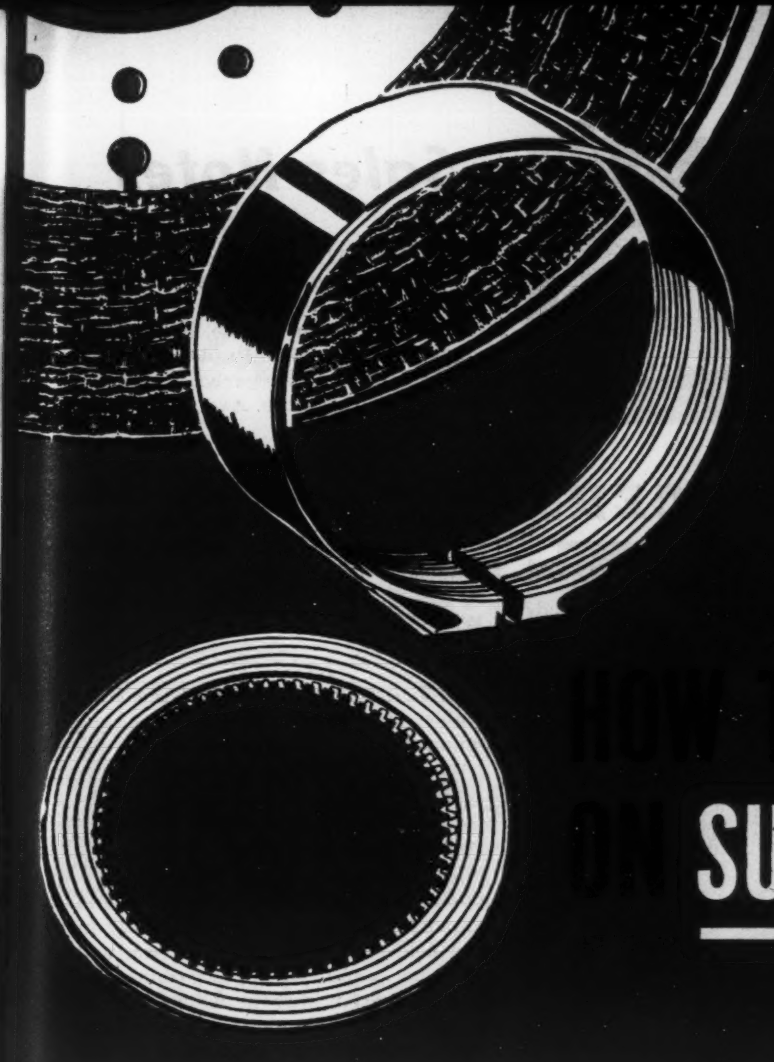
According to an announcement by the Molybdenum Corp. of America, Norman F. Tisdale has been made manager of sales for the company. He was formerly chief metallurgical engineer of the company.

◆

To assist in co-ordinating and directing all sales activities of the Radio Corp. of America tube department, W. L. Rothenberger has been appointed assistant general sales manager, under general sales manager L. S. Thees. RCA has also named M. J. Carroll to the position of manager of the equipment sales section. He will co-ordinate and direct sales to equipment manufacturers.

◆

Located at 630 North Prior Ave., St. Paul, Minn., L. C. Newton has been appointed sales representative of the Titan Mfg. Co., Bellefonte, Pa. Mr. Newton's office will serve North Dakota and Minnesota.



HOW TO SAVE A BIG STEP ON SUB-ASSEMBLY LINES

Whatever your problems in brake or clutch assembly, you'll find the R/M representative a good man to consult. In many cases, he is able to make suggestions that save steps and save time in assembly operations.

Here's an interesting example. Where specifications call for a friction material bonded to a metal backing . . . a development with which you may not yet be familiar . . . R/M can supply the *complete* sub-assembly, finished to your special needs. You thus eliminate a purchasing operation, as well as several steps in fabrication and assembly!

If it is more practical for you to provide your own backing plate for bonding to the friction component, R/M will, without cost, provide manpower for instruction in the bonding process. The "know-how" is yours for the asking!

For further information, check with your R/M representative. At his call, ready to serve you, are four plants, four research staffs, and four complete testing laboratories . . . with a half-century's experience in brake and clutch applications.

RAYBESTOS-MANHATTAN, INC.

EQUIPMENT SALES DIVISION **620 Fisher Bldg., Detroit 2, Mich.**
445 Lake Shore Drive, Chicago 11, Ill. 4651 Pacific Blvd., Los Angeles 11, Calif.
1071 Union Commerce Bldg., Cleveland 14, Ohio
Factories: Bridgeport, Conn. Manheim, Pa. Passaic, N. J. No. Charleston, S. C.

RAYBESTOS-MANHATTAN, INC., Manufacturers of Brake Linings • Brake Blocks • Clutch Facings
Fan Belts • Radiator Hose • Mechanical Rubber Products • Rubber Covered Equipment • Packings
Asbestos Textiles • Powdered Metal Products • Abrasive and Diamond Wheels • Bowling Balls

R/M

FIRST IN FRICTION

MOTTO for 1949

DO IT FOR LESS

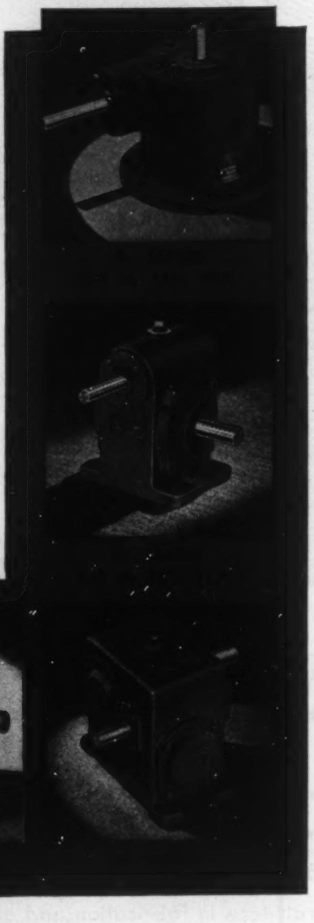
Yes . . . DO IT FOR LESS *with*

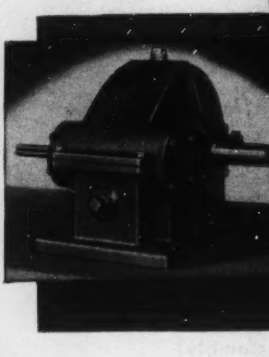
WINSMITH WHS SPEED REDUCERS **SPEED REDUCERS**

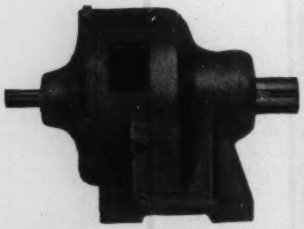
Back of the Tremendous Increase in Demand for the "Most Complete Line of Speed Reducers from any One Source" . . . . .

- √ **ECONOMY** ***in First Cost***
- √ **ECONOMY** ***in Operation***
- √ **ECONOMY** ***in Space-Saving***
- √ **ECONOMY** ***in Long Life***

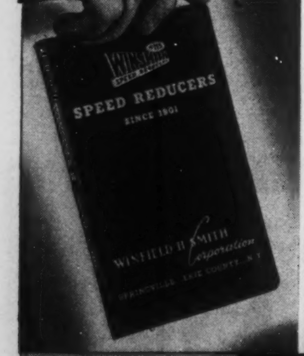
Let us consult with you in regard to COST-SAVING . . . no obligation







DIFFERENTIAL SPEED REDUCER
Straight Through Drive
1/10 to 81.5 H.P.



Send for Our Latest
POCKET-SIZE CATALOG

It covers our complete line . . . including the new, space-saving patented Winsmith Differential Speed Reducer. Gives ratios, horsepower, torque, overhung load capacities . . . includes valuable reference material and comprehensive Engineering Section. For Catalog 148, please write on your letterhead stating position.

see our CATALOG in SWEET'S FILE

WINSMITH WHS SPEED REDUCERS

WINFIELD H. SMITH CORPORATION

MEMBER OF AGMA

16 ELTON STREET
SPRINGVILLE . . . Erie County . . . . NEW YORK

Sales Notes

A NEW ALLEN-BRADLEY representative is the Young Electric Mfg. and Supply Co., 2134 Curtis St., Denver 2, Colo. Also, Bowditch and Co., Allen-Bradley factory representative, has opened a new office at 1350 Monroe Ave., Memphis, Tenn.

◆

The Chicago branch of the United States Rubber Co. has been moved to the Merchandise Mart building. This branch is the distributing point for Illinois, Michigan, Indiana, Iowa and Wisconsin.

◆

C. L. Carter, president of the Malleable Founders' Society, has announced the inauguration of an expanded and continuing research program to be undertaken immediately by the Society. The activity will include a study of methods, looking toward further improvement and development of manufacturing methods and expanded markets. A special study in the field of nodular graphite iron will also be conducted to determine the most effective way in which the industry's facilities and know-how may be employed in the production of this new type iron.

◆

Announcement has been made by the Minnesota Mining & Mfg. Co. that production of adhesives and coatings has been started at the former Plancor plant No. 80 at Bristol, Pa.

◆

Middle Western industries now have available to them services of Campbell Industries Inc., Mahonet, Ill., distributors of Pliobond, an all-purpose adhesive manufactured by the Goodyear Tire & Rubber Co.

◆

A new tank lining plant was recently put into operation by the B. F. Goodrich Co. at Tuscaloosa, Ala., offering freight savings, faster deliveries and proximity to southern suppliers of steel tanks.

◆

New roller chain distributors have been appointed by Diamond Chain Co. Inc. as follows: Apex Power Equipment Co., 4047 West 26th St., and Ray M. Ring Co., 1234 West Washington Blvd., both of Chicago; W. F. McGraw & Co., 575 E. Milwaukee St., Detroit, Mich.; Century Sup-

Choose from a broad selection . . .

Hanna valves

for efficient control

¼" UNITITE JR. VALVES

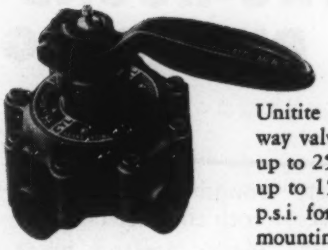
Hanna ¼" Valves control air, oil or water pressures up to 500 p.s.i. The control lever requires only 80° movement for reversal. Hanna ¼" Valves are 4-way but can be made 3-way, by plugging one port. Three models—column, standard and manifold mount—are available. Ideal for tubing and light piping.

SOLENOID VALVES

The Hanna 4-way Solenoid Valve is small, compact, with low current consumption. It is adaptable to straight line piping—capacity is equal to rated pipe size. Of balanced spool type, it has a built-in solenoid pilot valve. Piping may be from bottom, sides or a combination. Available in ⅜", ½", ¾" and 1" pipe sizes.

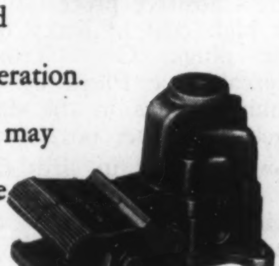
Hanna offers a versatile line of precision-made valves to answer your exacting control needs. All are designed and engineered for efficient, dependable operation. Whatever your valve control requirements may be, look to Hanna for the type and size you need. Hanna Valves have been used to advantage throughout industry for 40 years.

SEND FOR DETAILS . . .
Full information on Hanna's complete line of valves is yours for the asking.



HAND OPERATED UNITITE VALVES

Unitite Valves are suitable as either 3-way or 4-way valves, operating at air, oil or water pressures up to 250 p.s.i. for the ⅜", ½", and ¾" sizes . . . up to 150 p.s.i. for the 1" size . . . and up to 100 p.s.i. for the 1¼" size. Three styles—for standard mounting, column mounting or manifold mounting—are available.



FOOT OPERATED VALVES

Available in ⅜", ½", ¾" and 1" pipe sizes, Hanna Foot Valves are ideal for applications where it is desirable to have the operator's hands free for handling material. Single-pedal and double-pedal models, for pressures up to 250 p.s.i., are available for use with double-acting air and hydraulic cylinders.

SPEED CONTROL VALVES

For use with air or hydraulic cylinders, Hanna Speed Control Valves regulate inflow and outflow of either air or oil independently to and from one side of piston. Available in standard pipe sizes: ¼", ⅜", ½", ¾" and 1". They operate with pressures to 250 p.s.i. for air and 1,000 p.s.i. for hydraulic cylinders.

Hanna Engineering Works

HYDRAULIC AND PNEUMATIC EQUIPMENT . . . CYLINDERS . . . VALVES . . . RIVETERS

1765 Elston Avenue, Chicago 22, Illinois ply & Equipment Co., Akron, O.; Hines Bearing & Industrial Supply, Billings, Mont.; the Ross-Willoughby Co., Columbus, O.; Ralph Shawaker Co., Toledo, O.; Joseph E. Loughead Co., Kalamazoo, Mich.; J. W. Vaughan Co., Greenville, S. C.; Crossley Co., Erie, Pa.; the Mine & Smelter Supply Co., El Paso, Tex.; the Harry Cornelius Co., Albuquerque, New Mex.

◆

Two new representatives have been appointed by the Janette Mfg. Co., Henry W. Miller Elect. Co., 415 South 18th St., Omaha 2, Neb., serving Nebraska and western Iowa, and George E. Zweifel & Co., 103 S. W. Front St., Portland 4, Ore., serving Oregon, Washington and Idaho.

◆

A new fabricating mill has been opened by Revere Copper and Brass Inc. at 6500 E. Slauson Ave., Los Angeles. Headed by Wallace H. Hitchcock, division manager, the plant is expected to turn out more than a million pounds of copper products a month, to meet orders in Western states served by the new division.

◆

The Wagner Electric Corp. has purchased a plant containing 90,000 square feet at Mt. Vernon, Ill. The company is using the new plant for building transformer tanks.

◆

The mechanical goods sales division of Godyear Tire and Rubber Co. has recently been reorganized to form four sales divisions. O. A. Schilling will direct the Eastern sales division; H. E. Langdon, the Central sales division; and R. B. Warern will take over the Southern sales division. The Western sales division will remain under the supervision of R. G. Abbott.

◆

A new division of Tinnerman Products Inc. has been established by the company for its new Speed Grip nut retainer. The division is under the direction of Charles E. Pearson, coordinator of sales, production and engineering of the new product.

◆

To serve customers in the Youngstown, Cleveland, Erie and Buffalo areas, the American Brake Shoe Co. has located its National Bearing Division in the sales offices at 915 Midland Building, Cleveland. The enlarged office will be under the direction of James J. Nelson, eastern sales manager for National Bearing.

FULL STRENGTH SOCKET WON'T STRIP OR WEAR
AL
NEVER OUT-OF-ROUND, LEAKPROOF METAL-TO-METAL SEAL
LEN
NEW

ALLEN TRU-ROUND DRYSEAL PIPE PLUGS
100% Pressur-Formd

This newest Allen ⬡ Head product, made of Allenoy steel, meets all the demands of a dryseal plug in applications involving extreme pressure, such as in refrigeration and hydraulic equipment. For use with dryseal taps. No sealing compound required.

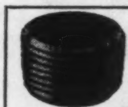
It stands up under repeated wrenching as no plug has before. Its Pressur-Formd socket, unweakened by drilling and broaching, is so strong the key will shear before the socket strips.

Pressur-Formd threading insures metal-to-metal contact all the way by producing burnished threads. This method prevents distortion and nicked, imperfect threads which gouge softer metals and impair the seal.

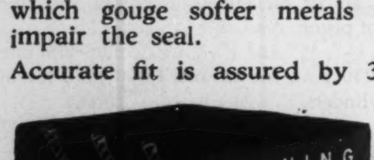
Accurate fit is assured by 360° roundness, and by a perfect taper, at both the pitch and crest diameters.

Here's positive protection against the high cost of leaky or faulty pipe plugs. Get "Tru-Round" Dryseal Pipe Plugs by ordering genuine Allens in the distinctive black and silver box.

Now available in sizes from 1/16" to 1¼". No increase in price. Write us for samples and engineering data.



FOR NORMAL APPLICATIONS Our "Tru-Round" standard pipe plug, also Pressur-Formd, is leakproof, and a sealing compound is not ordinarily needed for pressure-tight joints. Precise roundness and smoother threads make for better seal. Threaded strictly in accordance with Army-Navy Aeronautical Specification AN-P-363. Fully guaranteed.


WARNING
Allen-Type screws aren't necessarily Allen-Made. Get genuine Pressur-Formd Allen ⬡ Head screws in this black and silver box.

ALLEN
ALLEN HEAD
MANUFACTURING COMPANY
Hartford 2, Connecticut, U. S. A.
NEW YORK, CLEVELAND, DETROIT, CHICAGO, LOS ANGELES

ALLEN ..... FOR 40 YEARS THE BUY-WORD FOR SOCKET SCREWS

Where The Ultimate in Time-Saving Performance Is Demanded

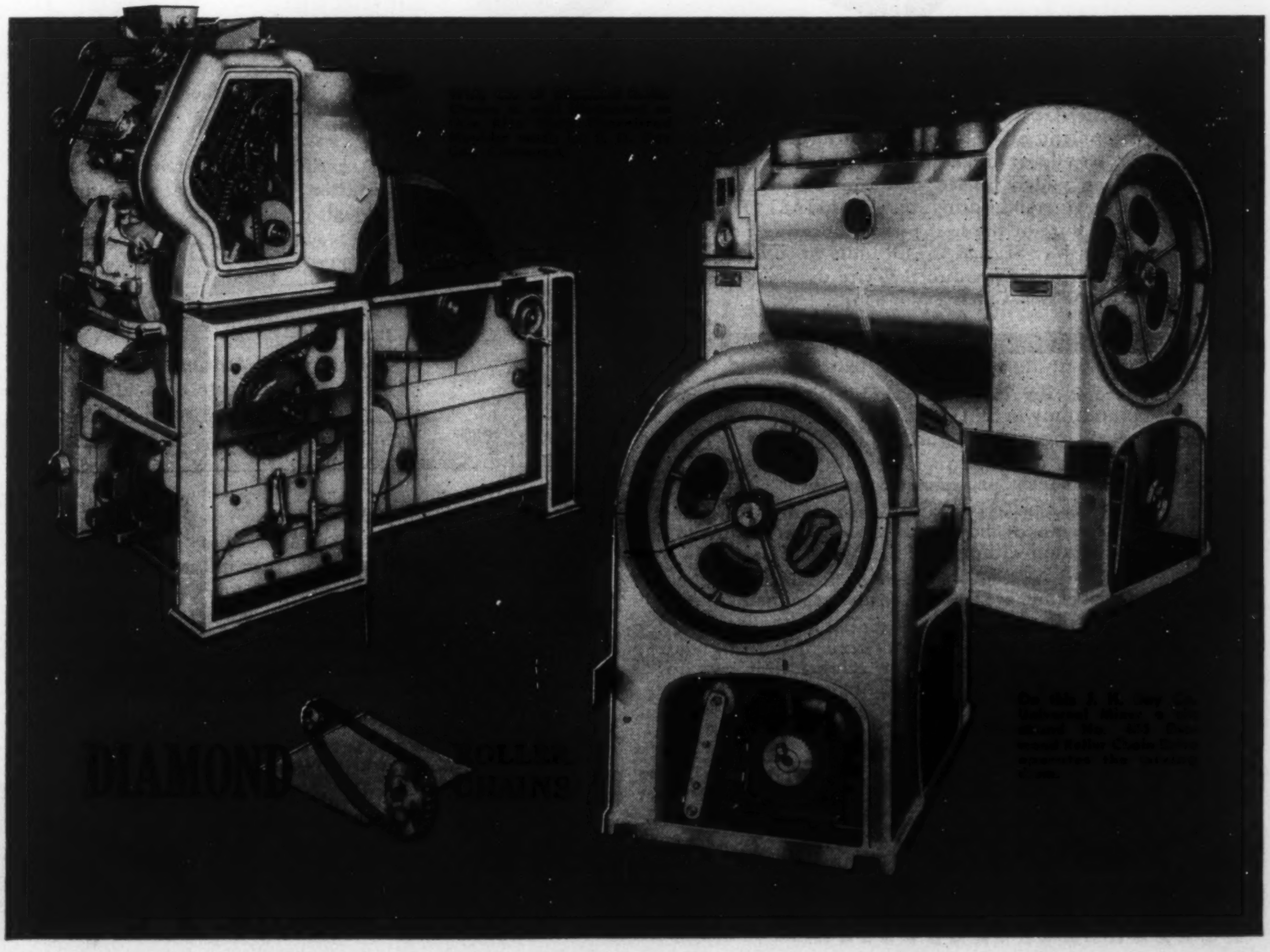
Machinery Designers Incorporate

DIAMOND ROLLER CHAINS

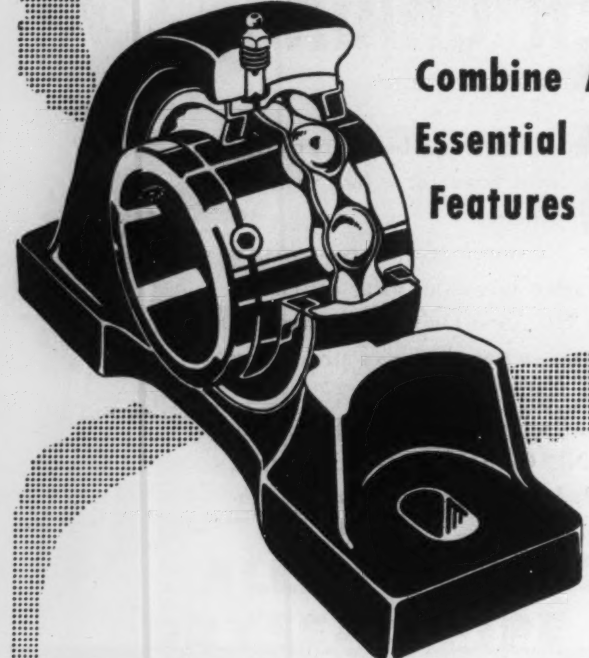
● Leading machinery builders intent on providing better and better performance and cost-cutting operation through greater output have for a half century made increasingly greater use of Diamond Roller Chains.

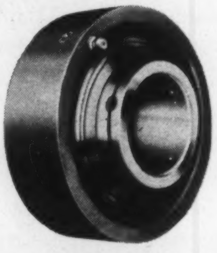
Long hours of service, dependability that cuts maintenance costs, positive non-slipping operation that insures high output, high power transfer efficiency that saves power, are important advantages. With Diamond Drives, the engineer designer can place his shafts where most practical, center distances presenting no problem.

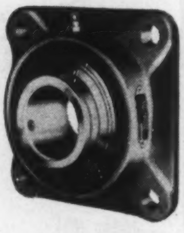
It is more than a coincidence that Diamond has served firms like J. H. Day Company since the turn of the century. DIAMOND CHAIN COMPANY, Inc., Dept. 435, 402 Kentucky Avenue, Indianapolis 7, Indiana. *Offices and Distributors in All Principal Cities.*

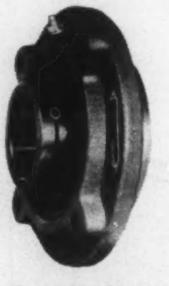


SEALMASTER
BALL BEARING UNITS




Cartridge Units


Flange Units


Flange Cartridge Units

SEALMASTER Ball Bearing Units have features that contribute to the good performance and long life of any industrial product on which they are used. Textile equipment, oil field machinery, farm implements and air conditioning equipment are only a few of the many widely varied fields in which manufacturers have standardized on SEALMASTER units.

To be sure of the best possible bearing performance, consider SEALMASTER units when designing, or redesigning products. Write us for a copy of SEALMASTER Catalog No. 845.

Here is the exclusive combination of features found only in SEALMASTER Ball Bearing Units:

- **Permanently Sealed** — Felt-lined, steel flinger, rotating in labyrinth, keeps dirt out and retains lubricant . . . prolongs bearing life.
- **Self-Aligning** — Bearing unit with seals independent of housing can align itself in any direction without seal distortion.
- **Pre-Lubricated** — Bearings are factory lubricated and are shipped ready for immediate use.
- **No Housing Wear** — Patented locking pin prevents rotation of outer race in housing and positions bearing for relubrication . . . no housing wear means quiet operation.

BEARING DIVISION
STEPHENS-ADAMSON MFG. CO.
18 RIDGEWAY AVENUE, AURORA, ILLINOIS
LOS ANGELES, CALIF. ★ BELLEVILLE, ONT.

Factory Representatives and Dealers in All Principal Cities

Meetings and Expositions

May 21-June 6—

Annual Paris Fair to be held at Paris, France. Additional information may be obtained from the French Chamber of Commerce of the United States, 630 Fifth Ave., New York,

May 26-27—

Society of the Plastics Industry. Annual conference to be held at the Edgewater Beach Hotel, Chicago, Ill. William T. Cruse, 295 Madison Ave., New York 17, N. Y., is executive vice-president.

May 30-June 10—

Canadian International Trade Fair to be held at Toronto, Canada. Additional information may be obtained from the Administrator, International Trade Fair, Exhibition Grounds, Toronto, Canada.

June 4-11—

First International Inventors Exposition sponsored by the American Inventors Association to be held in Grand Central Palace, New York. Serge Traye, 2 West 46 St., New York, N. Y., is secretary.

June 5-8—

American Gear Manufacturers Association. 33rd annual meeting to be held at the Homestead, Hot Springs, Va. Newbold C. Goin, Empire Bldg., Pittsburgh 22, Pa., is executive secretary.

June 5-10—

Society of Automotive Engineers. Summer meeting to be held at French Lick Springs Hotel, French Lick, Ind. John A. C. Warner, 20 West 39th St., New York 18, N. Y., is secretary.

June 20-23—

American Society of Agricultural Engineers. Annual meeting to be held at Michigan State College, East Lansing, Mich. Additional information may be obtained from society headquarters, P. O. Box 229, St. Joseph, Michigan. Raymond Olney is secretary.

June 20-24—

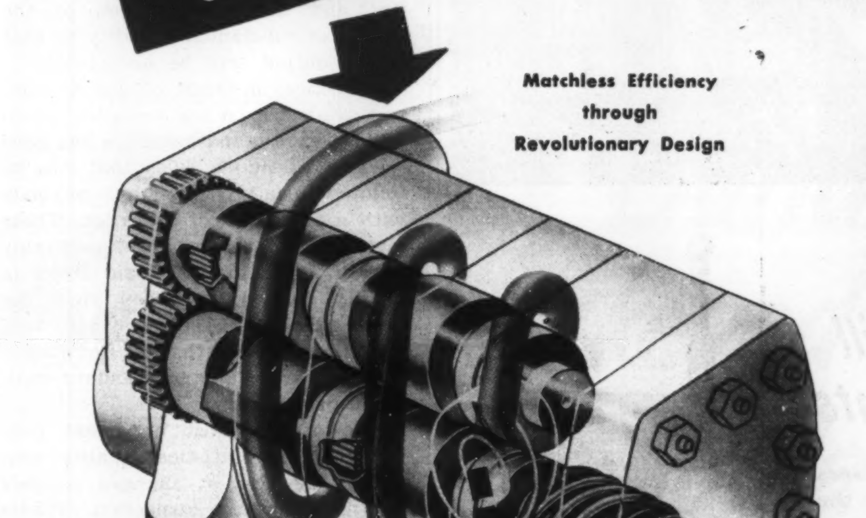
American Institute of Electrical Engineers. Summer general meeting to be held at New Ocean House, Swampscott, Mass. H. H. Henline, 33 West 39th St., New York 18, N. Y., is secretary.

Here's Your
SHORT CUT
To Better
PUMPING
(360° OF SMOOTH, CONTINUOUS FLOW)

BERRY
TRANSFER PUMPS
Move Liquids
FOR INDUSTRY

HIGHER EFFICIENCIES

. . . LOWER COST


VOLUMETRIC EFFICIENCY
MECH. EFF.
OVERALL EFF.
FLOW
INPUT H.P.
OUTPUT HYD. H.P.
PERFORMANCE CURVES ON 3202 LHP – 120 GPM PUMP AT 650 R.P.M.
120 80 40
100 60 30
40 20
20 10
100
200
300
400
500
PRESSURE - PSI
G.P.M
EFF %
H.P

Matchless Efficiency through Revolutionary Design

Patent Pending

The Berry Transfer Pump is the only pump made on the entirely new principle of a rotary piston. This principle makes higher efficiencies possible by eliminating pulsation and change of directional flow, thereby moving light or heavy liquids, gaseous liquids, and colloidals for industry with greater efficiency at lower cost.

***Absolutely unique in design and construction—with rotary piston, dual-cycle—the Berry Transfer Pump is* NOISELESS . . . NON-PULSATING . . . provides LAMINAR FLOW at rated capacities. *Pressures from 0-500 PSI. 0-240 G.P.M. It METERS as it pumps. Unsurpassed for extremely high or low temperature operation . . . low initial cost . . . low upkeep . . . long life.**

The Berry Transfer Pump affords greater efficiency with greater economy than any other liquid-moving pump obtainable. Fill out coupon for further information.

***The Berry Transfer Pump can be used for any general utility purpose for pressures not exceeding 500 PSI in standard units. Available in higher pressures upon analysis of special application.**

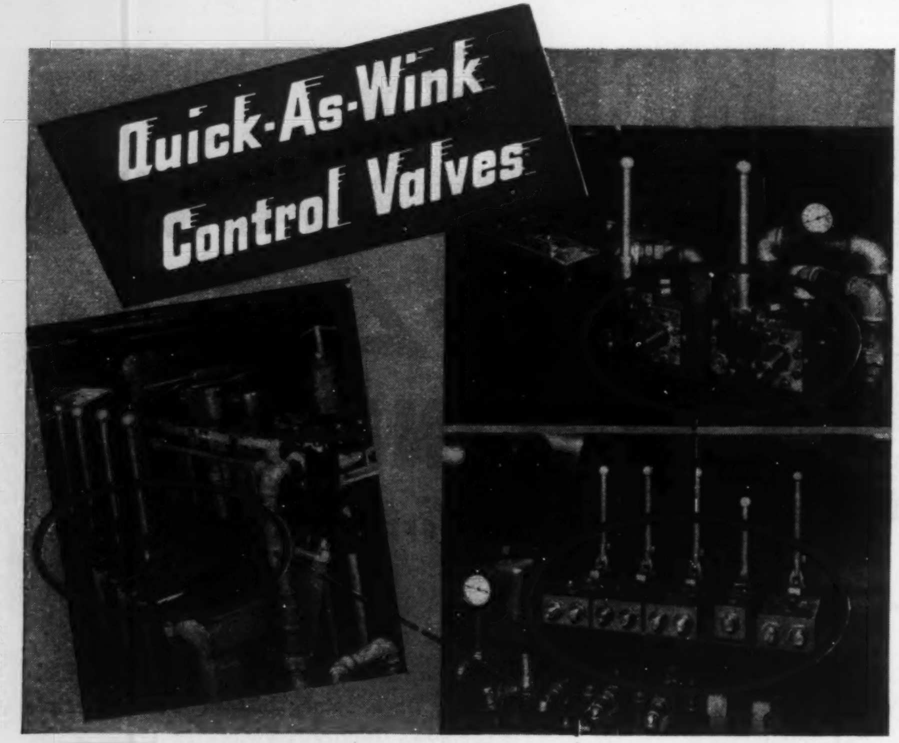
MAIL TODAY

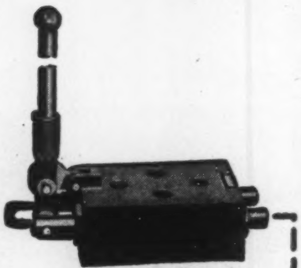
BERRY MOTORS, INC., Dept. E
Corinth, Mississippi

Please send information on Transfer Pumps ☐
Engineering service on specialized Hydraulic Power Transmission ☐

Name..
Title..
Company..
Business Address...
City..............................Zone.......State..................

BERRY MOTORS





Service proved for all steel mill requirements

● The view at the left above shows Quick-As-Wink Valves operating the pallet conveyor tilter, mandrel type feed reel carriage, and lowering and raising elevator on a 3/16" x 68" hot mill rotary flying shear. View at the upper right shows two 3-way Quick-As-Wink valves for a 56" rotary shear hydraulic piler. The view at the lower right above shows the control for a pallet conveyor tilter, feed reel hoist, and clamping mechanism on a 68" 2-high skin pass mill.

Other Quick-As-Wink valves are being used on run-out tables, mill stands, coilers and a wide variety of other steel mill equipment.

Furnished in hand and pilot cylinder operated designs for every industrial application. Let us quote on your requirements.

Quick-As-Wink Lever Operated Hydraulic Valves

The HS-551-N4 pictured above is a neutral position 4-way valve for controlling double acting cylinders. It has a machined steel housing, chrome plated and polished stainless steel plungers, and renewable metal rings to take the impingement of the liquid flow preventing wear on the U-packers. Used for oil or water up to 3500 P.S.I. and 150° F. Other valves available for pressures up to 5000 P.S.I.;— but send for a catalog today and get *full* details about the *complete* line.

Quick-As-Wink
Control Valves

THE HIGHER THE PRESSURE THE TIGHTER THE SEAL

Manufactured by C. B. HUNT & SON, Inc., *Salem, Ohio.*
Engineering and Sales Representatives in the Principal Cities

Design Abstracts

What Quality Control Does

IN general, quality control includes all the things you must do to manufacture in conformance with predetermined quality standards. More particularly, it consists of three basic steps: First, inspection to uncover any substandard quality in production; second, investigation to find out what is causing substandard quality; and third, elimination of the causes of substandard quality so that future output will be acceptable.

Statistical methods of quality control are based on mathematical probability, but the mathematics has been reduced to simple rules that can be followed successfully by anybody with a grade-school education. These methods can be employed profitably for all three of the basic steps in quality control, but they yield the most immediate returns when used for the first step; that is, for inspection to uncover any substandard quality in production.

One of the most important contributions of statistical quality control is the way it changes people's attitudes toward inspection. Plants not using statistical techniques generally regard inspection as a means of screening nonconforming product from satisfactory output, i.e., a means of detecting *past* mistakes. The basic principle of statistical quality control, by contrast, is to use hindsight as a guide to foresight. The primary purpose of inspection is considered to be elimination of causes of trouble so that future production will be free of defects. When inspection is used in this way, quality rises and the need for inspection as a means of detecting past mistakes is lessened. Thus, it becomes possible to reduce the cost of inspection and simultaneously improve quality.

Quality Control Cuts Waste

To summarize, statistical quality control provides an economic balance between the two risks of wasting money: The risk of looking for trouble *when there is no trouble* and the risk of failing to look for trouble *when there is trouble.* Statistical quality control results in:

1. Better quality
2. Reduced costs
3. Less scrap and rework
4. Increased profits

Bundyweld*... keyed to your tubular needs

Want an open door to faster production, lower costs, higher quality, or better design in your tubular applications?

Latch on to Bundyweld Tubing!*

Bundyweld, made of steel, Monel, or nickel, is double-walled from a single strip, and copper-bonded throughout . . . for extra-strong tubing that's lightweight, ductile and leakproof, too. It can be bent without fear of its weakening or collapsing structurally, and is easily fabricated.

Manufacturers in such diverse fields as television, radiant heating, refrigeration, ranges, tubular toys and automobiles—to mention only a few—have found Bundyweld to be the answer to their tubular needs.

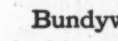
Chances are that this miracle tubing of industry can help solve your manufacturing problem . . . whether design, structural, or functional . . . even though you may not seem to need a tubing at all. Why not give it a try? Contact your near-by Bundy representative among those listed below, or write direct to: *Bundy Tubing Company, Detroit 14, Michigan.*

BUNDY TUBING

★ ★ ENGINEERED TO YOUR EXPECTATIONS ★ ★

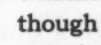
*REG. U. S. PAT. OFF. ®

WHY BUNDYWELD IS BETTER TUBING

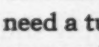


1 Bundyweld Tubing, made by a patented process, is entirely different from any other tubing. It starts as a single strip of basic metal, coated with a bonding metal.

2 This strip is continuously rolled twice laterally into tubular form. Walls of uniform thickness and concentricity are assured by close-tolerance, cold-rolled strip.



3 Next, a heating process fuses bonding metal to basic metal. Cooled, the double walls have become a strong ductile tube, free from scale, held to close dimensions.



4 Bundyweld comes in standard sizes, up to ⅝" O.D., in steel (copper or tin coated), Monel or nickel. For tubing of other sizes or metals, call or write Bundy.

BUNDY TUBING DISTRIBUTORS AND REPRESENTATIVES

Cambridge 42, Mass.: Austin-Hastings Co., Inc., 226 Binney St. • ***Chattanooga 2, Tenn.:*** Peirson-Deakins Co., 823-824 Chattanooga Bank Bldg. ***Chicago 32, Ill.:*** Lapham-Hickey Co., 3333 W. 47th Place • ***Elizabeth, New Jersey:*** A. B. Murray Co., Inc., Post Office Box 476 • ***Philadelphia 3, Penn.:*** Rutan & Co., 404 Architects Bldg. • ***San Francisco 10, Calif.:*** Pacific Metals Co., Ltd., 3100 19th St. • ***Seattle 4, Wash.:*** Eagle Metals Co., 3628 E. Marginal Way • ***Toronto 5, Ontario, Canada:*** Alloy Metal Sales, Ltd., 881 Bay St.

BUNDYWELD NICKEL AND MONEL TUBING IS SOLD BY INTERNATIONAL NICKEL COMPANY DISTRIBUTORS IN PRINCIPAL CITIES.

HERE'S GOOD
ARMCHAIR STRATEGY!
Ace Hard Rubber
eliminates time and
expense of upholstered
sub-assembly

YES, Ace hard rubber literally knocked the stuffings out of the arm for this chair. Formerly a padded, upholstered metal stamping bolted to the chair frame, it's now a one-piece, indestructible hard rubber molding, with leather-grain finish, and a feel that's just right.

What's more, it's assembled to the chair in a jiffy. You simply slide a headed insert into a slot, flex the rubber around the curve, and run up two screws from underneath.

You too may find "a better way" in one of the many Ace hard rubber or plastics molding and extruding compounds.

If you would like to know more about these Ace materials—where used—properties—design hints, etc., just write on your company letterhead for the new free 60-page Ace Handbook.

HARD RUBBER & PLASTICS HANDBOOK

ACE A — Since 1851
HARD RUBBER and OTHER IMPORTANT PLASTICS
AMERICAN HARD RUBBER COMPANY
11 MERCER STREET • NEW YORK 13, N. Y.

5. Improved consumer acceptance.

Statistical quality control is a precise scientific aid which minimizes the inconsistency of human judgment. A company not using statistical techniques is like a man trying to shave with an axe. It will soon find itself outstripped by its more progressive rivals who adopt a vigorous program of statistical quality control. *From a paper by David H. Schwartz, Quartermaster Corps Inspection Service, presented at the recent conference of the American Society for Quality Control in New York.*

Ideas Must Be Sold

NO doubt each of us knows of some company which in his opinion is so accustomed to doing a certain thing a certain way that he considers it to be in a rut. The surest way, in my opinion, to avoid "getting into a rut" is for a company to be sensitive to its consumer trade opinion of its product and services; of course, with an open mind. Sensitivity to customer opinion and reaction must be tempered with judgment and accompanied by action. It is impossible to please all of one's customers with any given design and it is urgently necessary that a conclusion on design be tested against some stable and logical yardsticks as opposed to customers' whimsical opinions.

Another likely way to help in keeping out of a rut is to draw new and inexperienced minds into a problem; almost invariably the person who didn't know it couldn't be done just goes ahead and does it.

To encourage creative thinking, an organization as such must demonstrate to its employees that it is open minded, receptive to new ideas, and ready to give recognition both tangible and intangible to the authors of worthwhile ideas. Engineers or technically inclined persons seem to be so constituted that the principal satisfaction required incident to an idea is that of seeing the idea take shape in the form of the finished machine and that of being recognized as the father of the idea. Suitable compensation must be forthcoming but is definitely not a substitute for the first two aforementioned satisfactions.

Good Ideas Are Scarce

It has been rightfully said that for every single good idea there are a hundred "also rans". This is a further interesting commentary on the personal characteristics of the technically minded author of ideas. He

SUCCESS
FOR YOUR IMPORTANT FORGINGS
IS ASSURED BY THIS BACKGROUND
NATIONAL FORGE AND ORDNANCE CO. IRVINE, PA.

This Forging...

is a rotor spindle for a steam turbine, subject to high rotative stresses. National Forge is one of the few companies with the experience to make such forgings with consistent success.

The problems in such work are many and varied. The analysis of steel selected for such forgings is such that quality must be assured. Steel must be forged under strict temperature controls, and after forging, the cooling process must be carefully guarded to avoid injury to the forging by thermal rupture. Heat treating also calls for careful adherence to prescribed treating cycle.

The inspection of such a forging must give complete assurance that all quality demands are met. This is not only true with respect to physical and dimensional requirements but also in the condition of the steel itself. To satisfy this demand such forgings are magnafluxed and usually have axial exploration holes bored for internal inspection of the forging. In addition to these tests of quality the forging must be stable at its operating temperature. Therefore, heat indication tests at temperatures above the operating temperature are taken to assure that there will be no distortion of the forging when in actual use.

These successive steps of production and testing, starting at National Forge with our own manufacture of basic electric steel, are carried out by an organization that has developed the highest skill and commands the most complete facilities in every department.

May we have your inquiry—when you require forgings for exacting duty?

NF

National Forge

AND ORDNANCE COMPANY

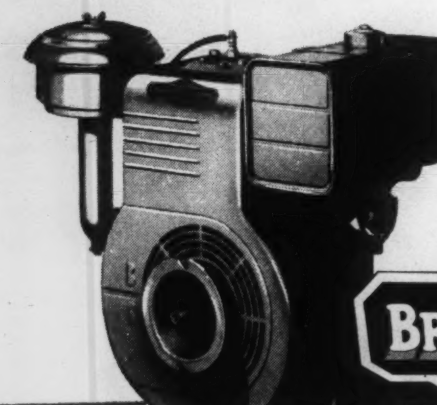
Irvine, Warren County, Pennsylvania

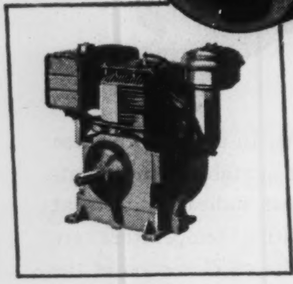
STEEL MAKERS ☆ FORGESMITHS
HEAT TREATERS ☆ MACHINISTS

More than ever..

the Leader

in the Field





Give Briggs & Stratton 4-cycle, air-cooled gasoline engines *any* job within their power range.

You'll soon see why Briggs & Stratton engines are recognized as the leaders in the field.

You'll find the Briggs & Stratton engines are tough, dependable, trouble-free — why they outperform and outlast any other engines of equal horsepower — and why they are today's outstanding power value.

BRIGGS & STRATTON CORP., Milwaukee 1, Wis., U. S. A.

Maintaining Leadership Since 1917, *more than 30 years without interruption,* it has been the aim at Briggs & Stratton to build the best 4-cycle, single-cylinder, air-cooled gasoline engines that engineering brains and precision manufacturing can provide.

The attainment of that goal is acclaimed by more than 4,000,000 engines which have been built and put into the hands of users.

Constant field and laboratory testing—constant developing and experimenting have added feature after feature, improvements and refinements.

New manufacturing processes, too, and ever-increasing precision in production and assembly are further assurance of the maximum in efficiency and performance.

Preferred Power
FOR INDUSTRIAL
CONSTRUCTION
RAILROAD AND FARM
EQUIPMENT

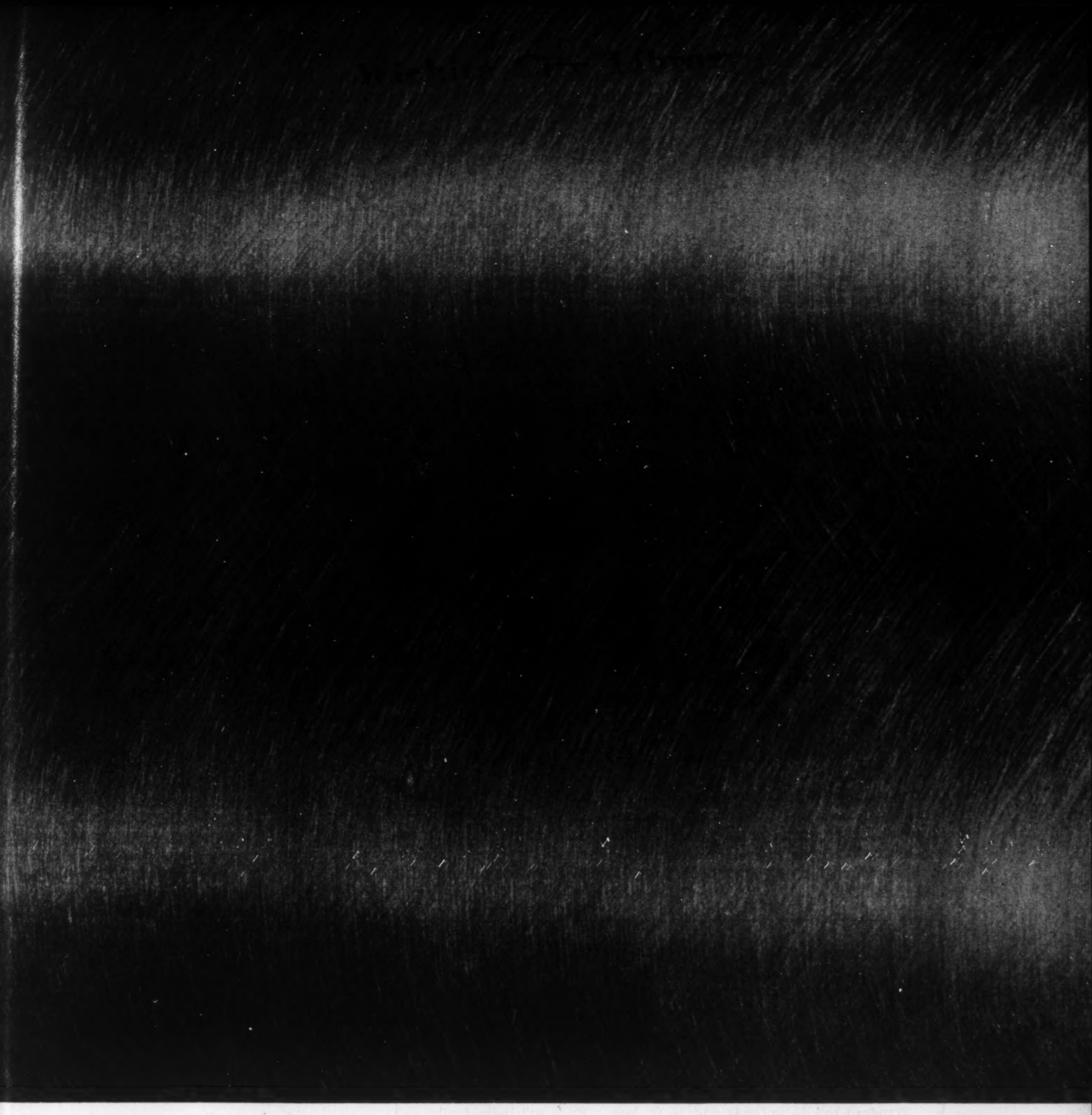
is not easily discouraged, he is thorough, and above all patient and persistent. Did you ever talk to a design engineer about a problem in his field when he did not have an opinion he was tremendously interested in outlining to you? I never have. If under that condition you ask the designer what he is trying to sell you he will hasten to assure you that he has nothing he is trying to sell you, he just wants to tell you about his idea; he couldn't sell you anything if he tried, etc., etc. The fact is that everyone of us is doing a selling job his every waking hour. If we are not successful in selling our services today we will have no work to do tomorrow. True, we are not particularly conscious of the sales effort, and that is good; that way we are not apt to be self-conscious —that might be bad.

It has been my unhappy experience to have been associated in a couple of instances in my practice of engineering with a particular type of young engineer who had a tremendously keen and productive mind and who regularly came forth with ideas. The attitude and viewpoint of the young man in question was that his sole purpose and function was to have ideas. Having had one brainstorm, he preferred to turn away seeking another idea, expecting someone else to recognize the value of his former effort and confidently assuming that someone else would grab his idea and run with it, thereby guaranteeing that it would see the light of reality.

Unsold Ideas Die

Sad to relate, no one else saw the value of the idea and it died at birth. The author of the idea was so certain of the value of it that he made no effort to sell it to anyone; he just began brooding over the unhappy state of a world, the queer inhabitants of which could not recognize a good idea when it came along. This self pity and brooding so affected the individual that he became incapable of thinking clearly on these problems. The net result was that he made life so miserable for himself and those around him that I say in all sincerity, good as the idea may have been, it would have been far better for himself and society if he had never had it in the first place.

So what? So it is not enough to have an idea! An idea worth having is an idea worth selling, and only the author of the idea can first sell it for he is the only one who knows enough about it to sell it to anyone else. It is equally important to know to whom it should be sold if it is



SUPERFINISH STARTS - OR STOPS - AT SCRATCH!

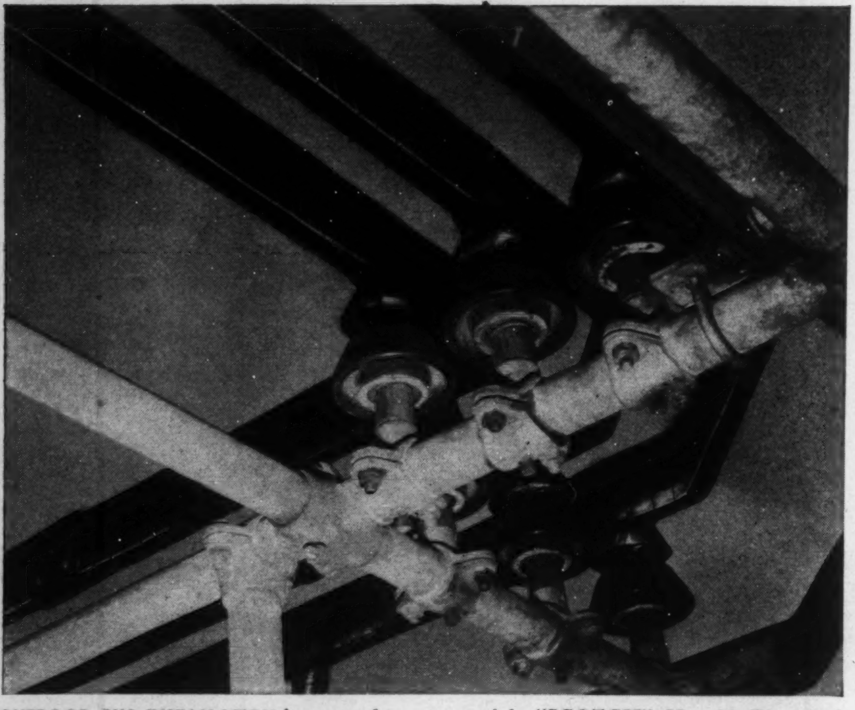
Perhaps you've thought of Superfinish only in terms of ultra-smooth surfaces. Not always! Here's one where the process has been stopped—controlled at a surface roughness of 10 micro inches. Note, in this magnification, how the abrasive grits have moved in paths which never duplicate, leaving a crosshatch pattern. For certain applications, such partially Superfinished surfaces have two distinct advantages: (1) removal of the soft "smear metal" left by grinding heat, (2) the crosshatch pattern maintains uniform distribution of lubricant to discourage spalling.

Superfinish has many other interesting applications. Write on your letterhead for the booklet, "Wear and Surface Finish."

GISHOLT
MACHINE COMPANY
Madison 10, Wisconsin

THE GISHOLT ROUNDTABLE *represents the collective experience of specialists in the machining, surface finishing and balancing of round and partly round parts. Your problems are welcome here.*

TURRET LATHES • AUTOMATIC LATHES • SUPERFINISHERS • BALANCERS • SPECIAL MACHINES



OUTDOOR BUS INSTALLATION is exposed to extreme temperature, sunlight, moisture and corrosive gases. Yet the insulating material, "SCOTCH" No. 33 Electrical Tape, on the bars and leads is unaffected.

Get two-way protection with this NEW tape

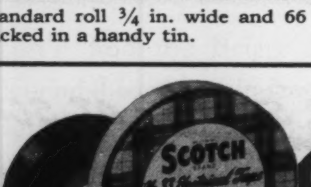
The tough plastic backing on "SCOTCH" No. 33 Electrical Tape gives a high dielectric strength plus sturdy resistance to weathering and corrosion—making an efficient insulation for practically every type of electrical job.

Give this remarkable NEW "SCOTCH" Electrical Tape a try. You'll find it's easier to apply than other materials—gives you a neater, more compact job. Write Dept. MD-5 for complete information and a free sample.

Quick facts about "SCOTCH" No. 33 Electrical Tape

- **HIGH DIELECTRIC STRENGTH**—insulates perfectly against charges of over 7,000 volts.
- **TOUGH**—plastic backing resists abrasion, water, acids, alkalies, alcohols.
- **THIN CALIPER**—only .007" thick, requires less room in all insulation work.
- **STRETCHY**—conforms snugly to uneven surfaces, irregular shapes.
- Carries the seal of Underwriters' Laboratories.

Standard roll 3/4 in. wide and 66 ft. long. Each roll individually packed in a handy tin.



REG. U.S. PAT. OFF.
SCOTCH
BRAND
No. 33 Electrical Tape

ANOTHER 3M PRODUCT

Made in U. S. A. by
MINNESOTA MINING & MFG. CO., Saint Paul 6, Minnesota
General Export: DUREX ABRASIVES CORP., New Rochelle, N. Y.
In Canada: CANADIAN DUREX ABRASIVES LTD., Brantford, Ontario

to see the light of day. This latter point is one with which no one outside of your organization can help you, but it is important.—*From an address by Fred E. Harrell, Mfg. Vice Pres., Reliance Electric & Engrg. Co., delivered before the Machine Design Division of Cleveland Engineering Society.*

Why Quality Control?

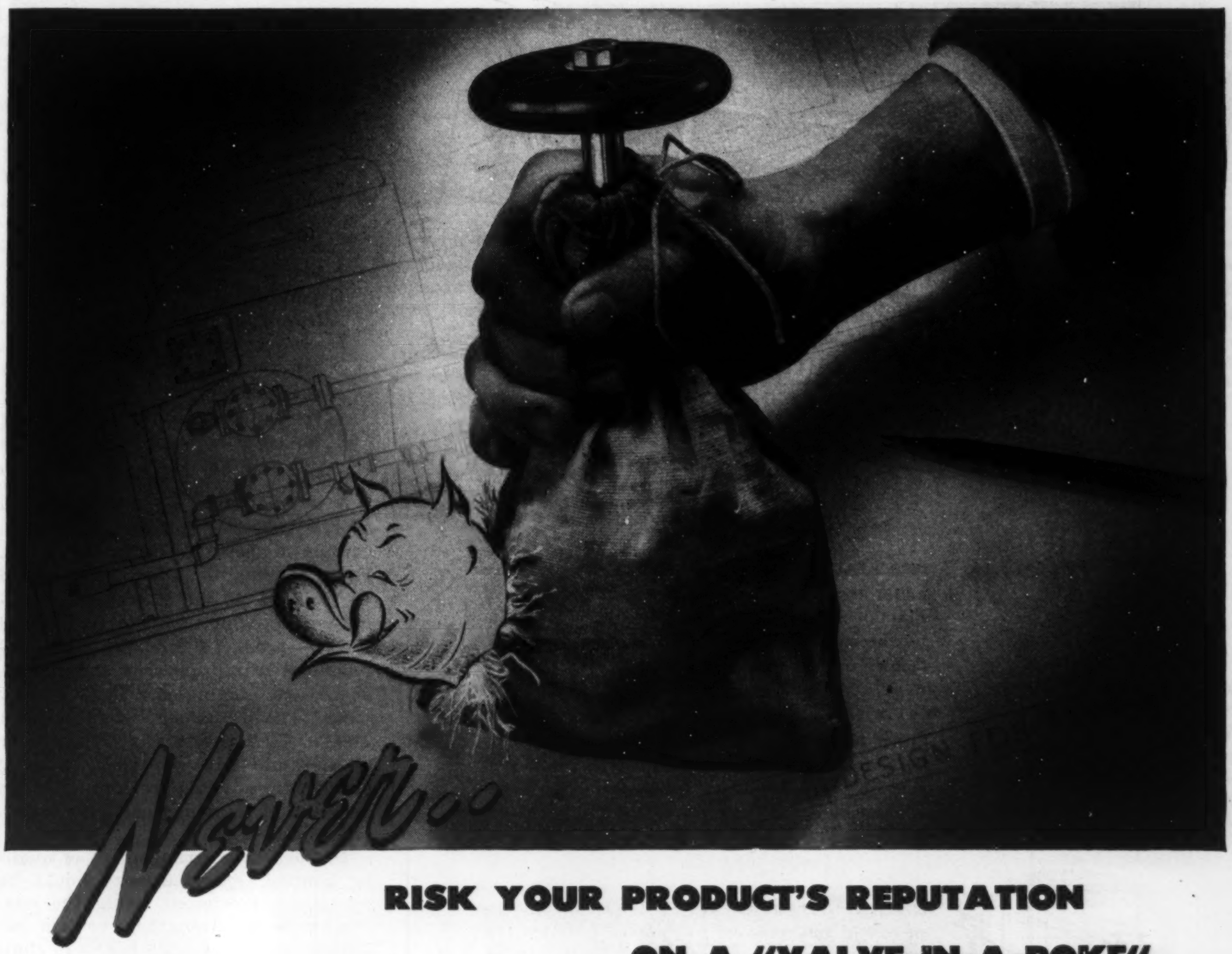
UNDOUBTEDLY the most important reason for quality control lies in the sudden awakening of industry to the fact that 100 per cent terminal inspection, at best, is not highly reliable. Men in the Bell Telephone Laboratories have recognized that fact for many years. The rest of us in industry generally have had to be shown. In our own company we have run a series of experiments to convince ourselves. We applied 100 per cent inspection on some visually determinable quality characteristics, using selected personnel without them being aware of the experiment. Careful reinspection indicated 85 per cent reliability. Units which had already been subjected to 100 per cent inspection were again reinspected and overchecked. The reliability was then 89 per cent. The experiment was continued with the following results:

100 per cent inspection	85 per cent reliability
200 per cent inspection	89 per cent reliability
300 per cent inspection	92 per cent reliability

We were sufficiently convinced to discontinue the experiment. When these data are extrapolated it is indicated that some 800 per cent inspection would be required to approach the 99.73 per cent assurance which can be obtained with quality control. Given a free choice in the matter, which treatment would you prefer to use?

The newer scientific control philosophy is a living thing having great dynamic forces for progress. It helpfully concerns itself with detecting the causes for variations in product characteristics and with correcting them rather than accepting or rejecting with an indifference to cause. If used merely to determine process capabilities it will more than pay for its cost.

A first step in introducing quality control is establishing a need for it by actually showing the existing quality and waste levels in a specific activity. This can be done by a sampling of current production. With the economics developed, a plan for



RISK YOUR PRODUCT'S REPUTATION ON A "VALVE-IN-A-POKE"

A valve carelessly chosen and installed in your product is literally a "pig-in-a-poke." You never know how much it will cost you in excessive servicing expense. You never know, either, how much damage its faulty operation will do to your product's reputation, no matter how well made otherwise.

When you choose Jenkins Valves, you eliminate all uncertainty and risk. You give your product the advantage of Jenkins' 83-year reputation for supplying valves of top-rated construction and performance. You know that you have selected the right patterns and placed them correctly in the assembly, because you can add the valve know-how of Jenkins Engineers, whenever necessary, to your own designing skill.

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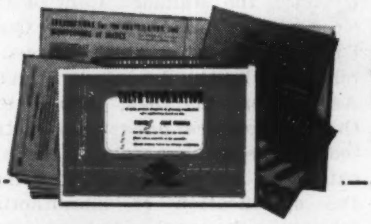

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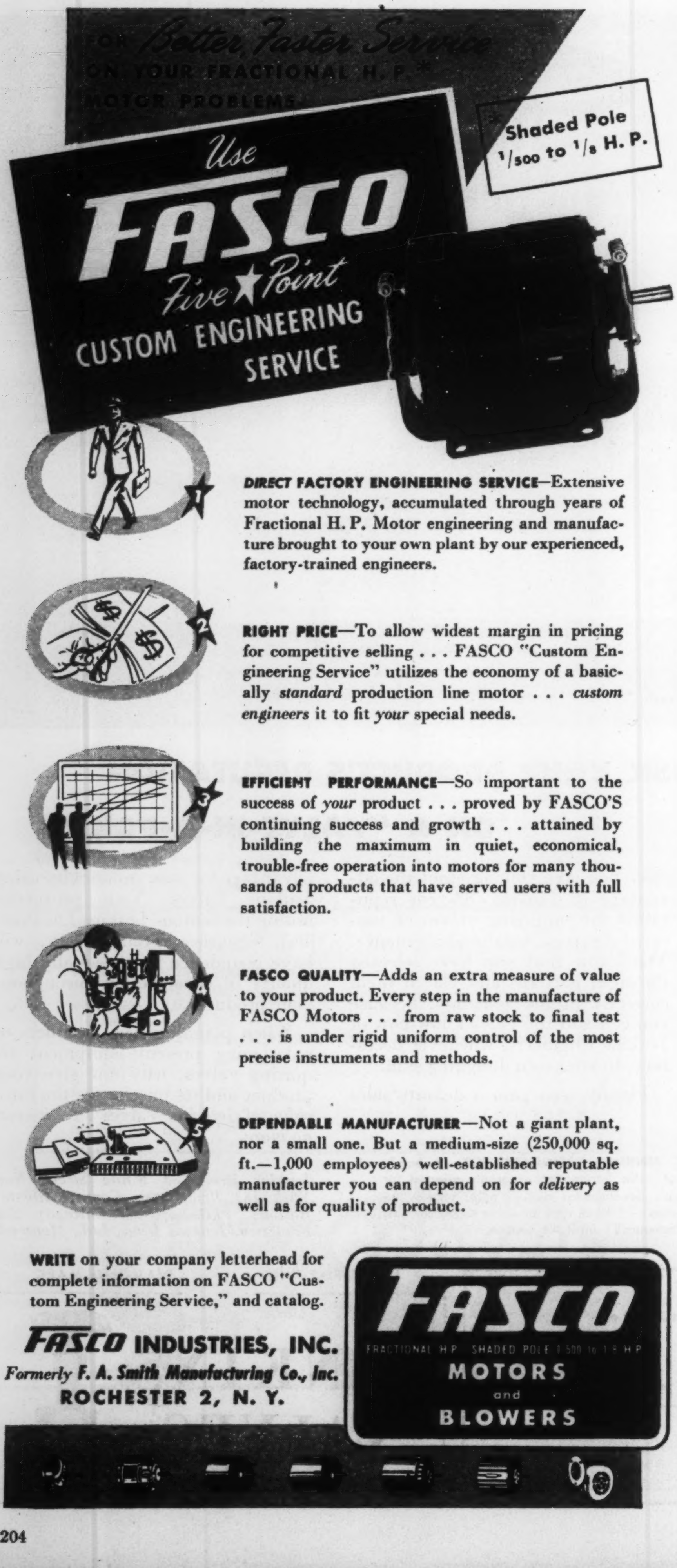

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controlling quality can be presented to management. In this presentation two points should be remembered.

1. Management is not interested in buying greek letters or statistical concepts. It is interested in any technique which proposes to keep quality in control as production continues rather than to produce, sort, and destroy or repair the defectives
2. You are not selling something that you have suddenly discovered but are proposing something which management has been eager to buy for many years and has only been waiting for someone to present in a simple and staightforward manner.

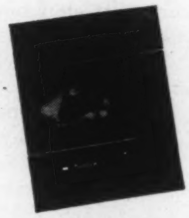
A second step is the preparation of raw material and product specifications if they do not already exist. Even if they do exist they should be revised to eliminate those requirements which are not meaningful in the product's intended use. All indefinite words, phrases and clauses should be eliminated. "Substantially clean", "Workmanship shall be first class", etc., are actually escalator clauses and have no place in good specifications. Requirements should be reduced to numerical values with tolerances.

In the whole arrangement of quality control, specifications should be continually reviewed, using the control data to strengthen certain requirements which need it and to eliminate other requirements which are not meaningful in terms of the product's intended use. *From a paper by E. H. MacNiece, director of quality control, Johnson & Johnson, presented at a recent conference of the American Society for Quality Control in New York.*

Quality Control as a Co-ordinating Tool

SINCE the standard Control Chart Method for Controlling Quality During Production was approved and published by the American Standards Association in 1942, about thirty thousand copies have been distributed. A specific example of the application of the control chart concerns the specification of manufacturing tolerances for mechanical components by the engineering department of a manufacturing concern.

The designer adopts these tolerances primarily on the basis of what he thinks is required in accuracy of the parts with a view to their proper assembly and the smooth performance of the product as a unit. The shop is, of course, expected to



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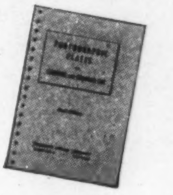

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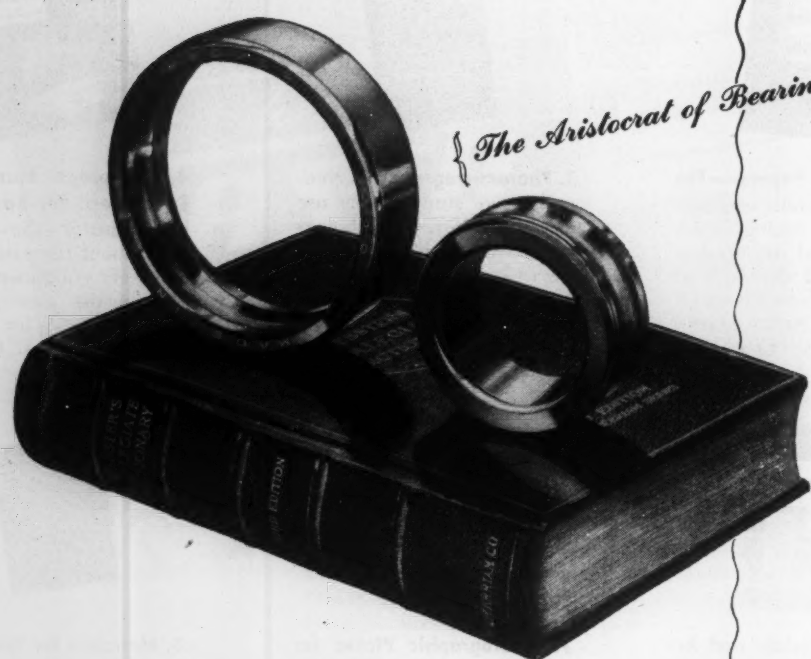

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maintain these tolerances in making the parts. However, it often happens that the shop finds the tolerances as specified on the drawings too close for being maintained with the equipment available, the result being a large number of rejects. It may be that the trouble could be eliminated by giving the shop larger tolerances, but the engineering department objects to this on the ground that it would impair the performance of the product. Also, in some cases the engineering department will express doubt that the shop really cannot hold the closer tolerances if sufficient care is used. Without the control chart, there is no criterion definitely showing the two parties what can reasonably be expected of the shop, and so it is a common experience to see both the engineering department and the shop stick to their guns. Both parties feel that they are experts in their own field; one in regard to the demands of the product and the other in regard to the capability of the production process.

Thus the high percentage of rejects might continue, accompanied by great loss of time, effort, money, and temper. This proves, again, the advantage of having the control chart, in our modern setup, which will tell both parties what the best is that can be expected of a production process; that is, what its capabilities are, in terms of accuracy, when the state of control has been attained. If this "best" is not good enough for satisfactory performance of the product, both parties should realize that there is nothing to do but make a basic change in the process so that it will meet the requirements, unless recourse is taken in selective assembly, which complicates matters and, therefore, is avoided if possible.

Another and at least equally important point is that the quality control chart, by presenting a clear picture of what the process can do, assists in arriving at a meeting of minds. Evidently, once the maximum capability of the production process has been determined, there no longer is any reason, nor any excuse, for the designer to specify manufacturing tolerances that manifestly cannot be maintained in the shop. Thus, the control chart appears to be valuable, not only in getting and keeping control of quality, but also in setting up practicable and economic standard specifications to begin with. It becomes an essential aid in co-ordinating what we want to do with what we are able to do. *From a paper presented by Dr. John Gaillard, American Standards Association, at the recent conference of the American Society for Quality Control in New York.*

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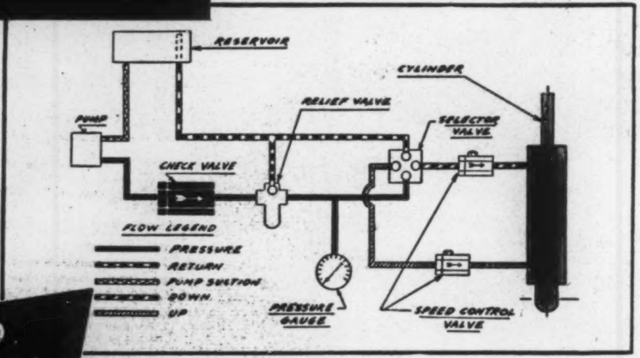
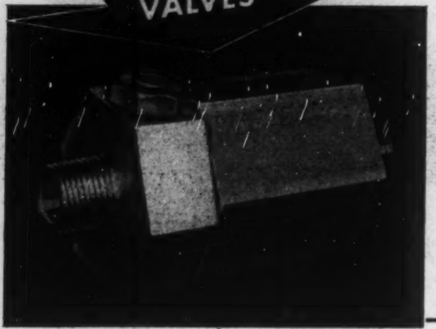


Illustration shows use of Electrol Check Valve in system to prevent loss of pressure through pump when unit is shut off.

SPEED CONTROL VALVES



ELECTROL SPEED CONTROL VALVES allow flow in one direction and — by use of a metering device—provide controlled flow in the opposite direction. Flow is controlled by a screw-actuated metering pin in the side of the valve. With pressures up to 1,500 p.s.i. and more, this valve handles air and oil with equal facility, at high or low pressures. Standard sizes: ⅛", ¼", ⅜", ½" and ¾" NPT ports. Special sizes to order.

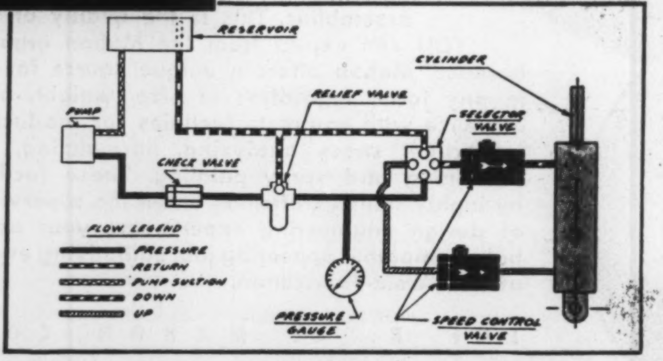


Illustration shows use of Electrol Speed Control Valves in conjunction with actuating cylinder to control speed of piston rod motion in both directions.

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REPRODUCTION MACHINES. For making direct positive prints with no reversing of black and white values. Three models; large-volume automatic production, moderate-volume, and small-volume production machines. Copies made of drawings, documents or any work drawn, printed, typed, or written on translucent material. Charles Bruning Co. Inc., Chicago, Ill.

Commercial

DRY BEVERAGE COOLERS. For cooling of cold drinks for retail establishments. Line of 6 units includes 3 self-contained units and 3 others requiring remotely located refrigerating units. Cabinets are 40 in. high, made of steel and finished in metallic bronze trimmed with stainless steel. Diffusion type cooling unit uses fan for rapid chilling of bottles. Frigidaire Division, General Motors Corp., Dayton, O.

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AUTOMATIC TOASTER. Either 2 or 4-slice models. For a-c or d-c operation. Silent in operation, toaster has accurate clock and thermostat control. Includes removable bottom plate for cleaning, mica elements, nichrome ribbon, and is finished in chrome. Toastswell Co., St. Louis, Mo.

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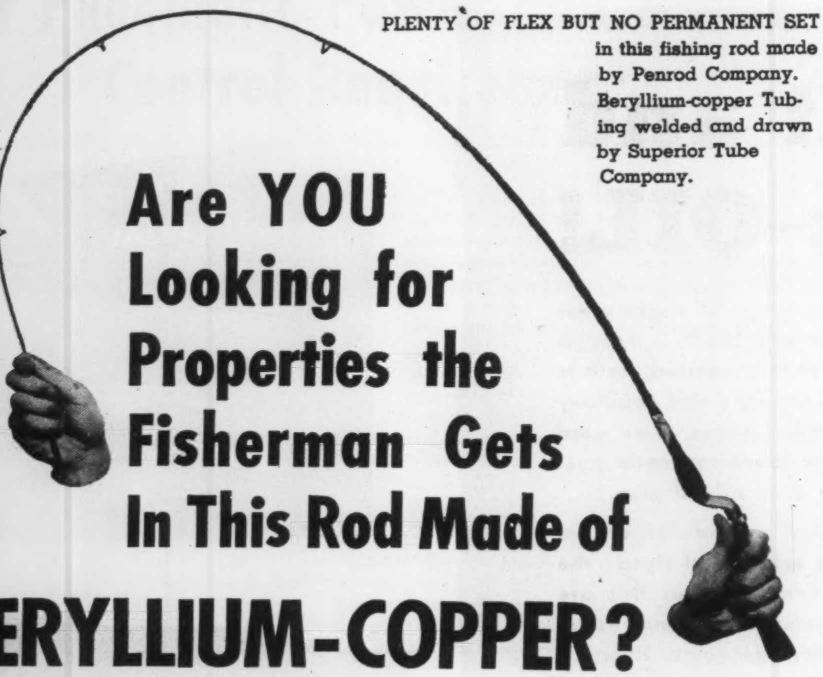

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Strip Tempers	Tensile Strength	Elongation	Elastic Limit	Rockwell Hardness
Before Heat-Treatment				
Annealed	70,000	35	20,000	B60
1 No. Hard	80,000	10	35,000	B75
2 No. Hard	90,000	5	50,000	B90
4 No. Hard	100,000	2	60,000	B95
After Heat-Treatment				
Annealed	170,000	6	80,000	C37
1 No. Hard	180,000	4	90,000	C39
2 No. Hard	190,000	2	100,000	C41
4 No. Hard	200,000	1	110,000	C43

CORROSION RESISTANCE. Having the inherent corrosion resistance of copper, BERYLCO 25S is dependable in marine and industrial atmospheres without the addition of protective coatings which may abrade or crack in use. Beryllium-copper also is unaffected by "season cracking" and hydrogen embrittlement.

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Strip—in reverse bending	40,000—50,000 psi
Rod—rotating beam Wire—rotating arc compression spring	45,000—60,000

ELECTRICAL AND THERMAL CONDUCTIVITY. Heat-treated BERYLCO 25S has a conductivity of 23 to 30% that of copper. This, combined with excellent spring properties, accounts for its successful use in many current-carrying applications.

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wire embedded in finned aluminum grid. Grid remains at low temperature, has high thermal conductivity. Wall mounted. Electromode Corp., Rochester, N. Y.

Oil-Fired Flash Boiler. For hot water radiant heating domestic installations. Capacities, 100,000, 169,000 and 220,000 Btu output. Coil made of standard 1¼-in. diameter steel pipe. Boiler has efficiency rating of 80 per cent, requires 3 by 5-ft floor space. Seidelhuber Iron & Bronze Works Inc., Seattle, Wash.

Window Fans. Capacities; 5000 cfm for 24-in. fan, 6500 cfm for 30-in. fan. For installation in upper or lower portion of double hung windows or on walls. Fans have rubber-mounted motors, are finished in baked enamel. Emerson Electric Manufacturing Co., St. Louis, Mo.

Adjustable Window Fan. Portable, direct drive, 12-in. fan delivers 1000 cfm. Powered by 1/25-hp motor at 1550 rpm. Width adjustable from 25 to 36 in. to fit upper panel of any standard window. Chelsea Fan & Blower Co. Inc., Irvington, N. J.

Room Air Conditioners. Self-contained package units cool, dehumidify, filter, circulate and ventilate. Capacities: ¾-hp unit for larger rooms, 8876 Btu per hr; ½-hp unit for medium-sized and small rooms, 5580 Btu per hr. Refrigerating mechanism hermetically sealed and has rubber mounted and sound insulated motors. Units suitable for double hung windows, require no plumbing connections and plug into 110-125 volt a-c. Mitchell Manufacturing Co., Chicago, Ill.

Air Circulator. Two-speed, 16-in., 4-bladed aluminum fan delivers 2000 cfm. Mounting panels adjustable from 27½ to 36 in. wide. Also can be mounted without panels for windows 16 to 27 in. wide. Emerson Electric Manufacturing Co., St. Louis, Mo.

Maintenance

Air Impact Wrench. Handles studs, bolts, nuts and cap screws from 1¼ to 2-in. thread size. Operates on rotary impact principle, delivering 1000 blows per minute. Weight, 72 lb less socket. Ingersoll-Rand Co., Phillipsburg, N. J.

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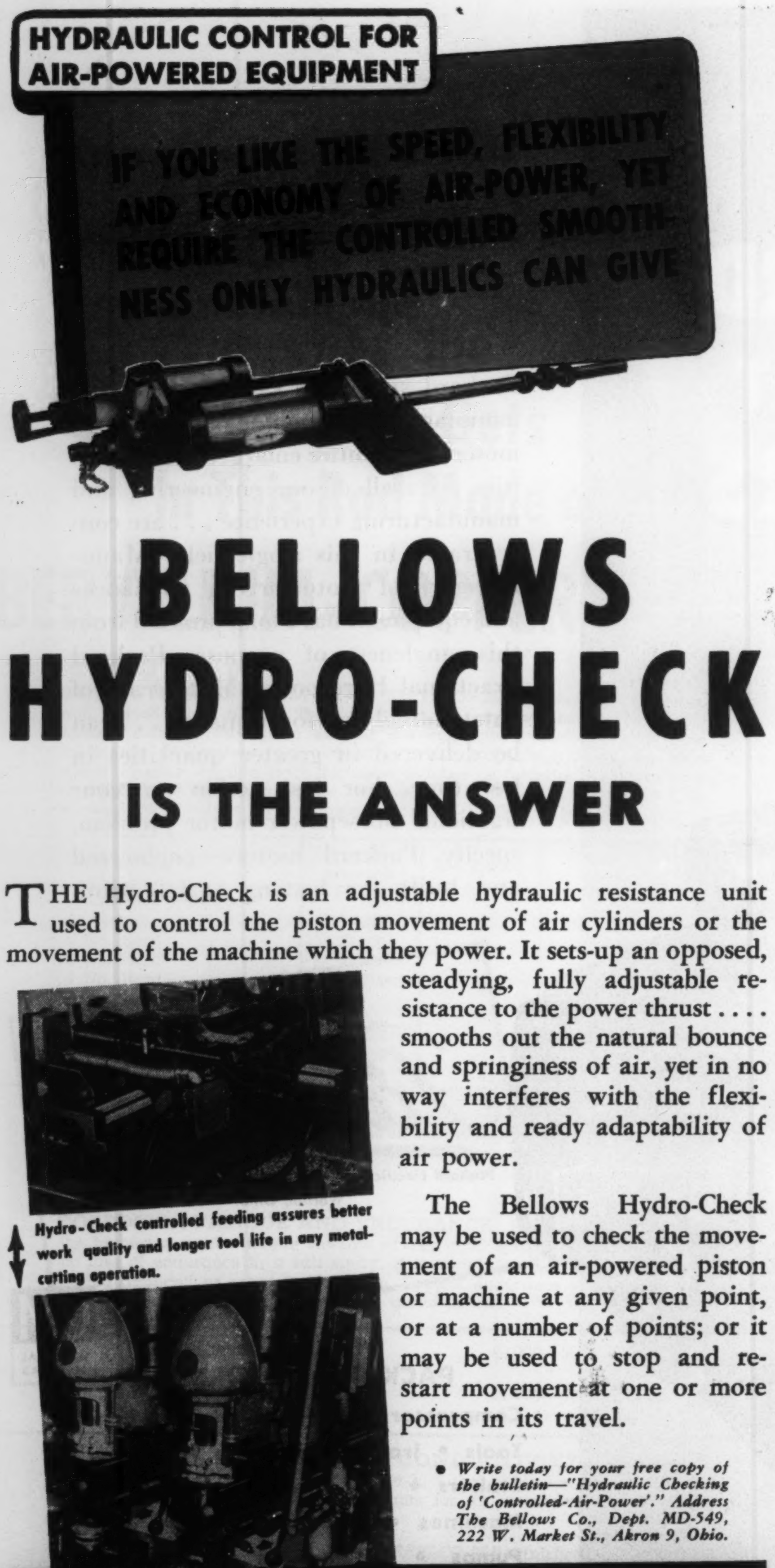

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rate, low rate, aging and line voltage variations. Charging cycle is automatic. Unit designed for 230 or 460 volts. Westinghouse Electric Corp., Pittsburgh, Pa.

FLOOR POLISHING MACHINE. Has 18½-in. brush spread; powered by ¾-hp motor. Offset motor design counterbalances handle. Adjustable handle equipped with safety switch. Kent Co. Inc., Rome, N. Y.

POWER LAWN MOWER. Two models have 24 and 30-in. cutting width. Rubber-tread traction wheels at rear, within cutting width. Five heat-treated alloy steel blades on 6-in. reel are mounted on tapered roller bearings. Cutting height adjustable between ½ and 2 in. Moto-Mower Co., Detroit, Mich.

HAND-OPERATED LUBRICATOR. Portable. Requires no air or electricity. For servicing of industrial equipment. Special push-squeeze handle enables operator to develop pressures to 7500 psi. Greaser fits any standard 25 to 40-lb original grease container. K-P Manufacturing Co., Minneapolis, Minn.

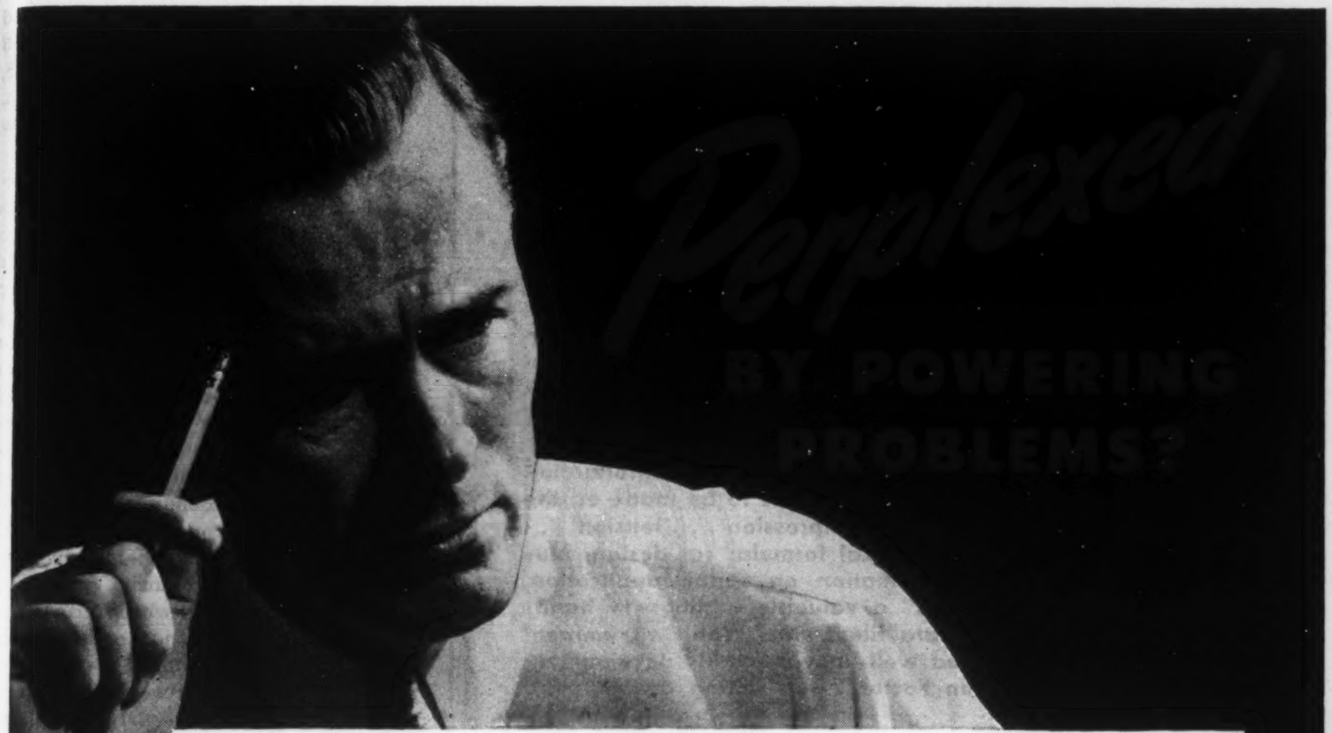
TOTE BOX CLEANER. Combination drum and belt type washing machine cleans tote boxes and miscellaneous parts. Boxes are turned over, washed and discharged; parts are hopper fed or loaded onto belt, cleaned and discharged. Cincinnati Cleaning & Finishing Machinery Co., Ironton, O.

Manufacturing

PRODUCTION PRESSES. Line of medium to high tonnage mechanical presses for stamping operations using standard, progressive, or multiple dies. Units have speeds to 250 strokes per minute, capacities of 50 to 800 tons. Drives available include: direct nongeared, crank-drive; single-reduction gear, eccentric drive; and double-reduction gear, eccentric drive. New floating friction block clutch is fan cooled, air operated, and is externally mounted to simplify maintenance. Cramer-Krasselt Co., Milwaukee, Wis.

COLOR FILLING MACHINE. Places color enamel filling into stamped, embossed, molded, cast and diecast parts. Design may be flat, curved, concaved or convexed. Hand-operated machine carries enamel from platen shaped to match surface being filled by means of a molded rubber die. Acromark Co., Elizabeth, N. J.

EXPERIMENTAL MOLDING MACHINE. For low-cost injection molding of Bakelite styrene and other thermoplastic materials. Capacity, ¼ oz. Unit is designed for use with drill



Perplexed BY POWERING PROBLEMS?

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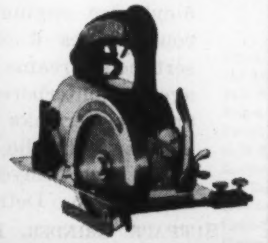
There's *magic* in good modern design. It pays off in lower costs . . . in high demand . . . in profits and prestige. Nowhere is this better proved than in the field of small power-tools, where motors must *conform* to the product. That's why the Porter-Cable Machine Co., and other leading makers, look to Robbins & Myers for their powering. It has been this way for years.

PLANNED PERFORMANCE—These are not jobs for *regular* motors, but for R & M Matched Motor Parts, designed to meet size and shape limitations, yet developing ample horsepower. They're compact, rugged—take overload, abuse—and they help to create the *user-enthusiasm* that builds a big sales volume for products customers want.

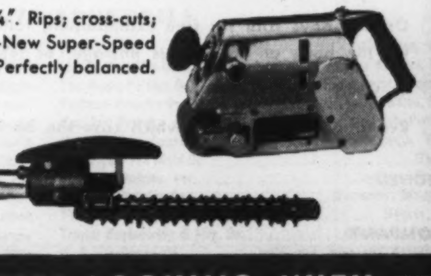
CONVENIENCE AND ECONOMY—For portable equipment, or anything else that needs *dependable,* built-in power, R & M Matched Motor Parts offer both convenience and economy. Dimensional interchangeability of all motor types provides *utmost versatility.* A complete line of standardized elements simplifies selection. And R & M designs and builds to *individual* requirements.

MILLIONS OF UNITS IN USE—We'll be glad to send you, free, our 32-page booklet, "Matched Motor Parts." It's packed with useful information for designers—a result of more than *fifty years* of service to progressive manufacturers. Please address Robbins & Myers, Inc., Motor Division, Dept. E-59, Springfield 99, Ohio.

TYPICAL PORTER-CABLE HAND TOOLS POWERED BY ROBBINS & MYERS



At left—the Guild Saw, for cuts up to 1¼". Rips; cross-cuts; tilts for bevels. Weight, 6¾ lbs. Below—New Super-Speed Hedgshear. Won't stall on toughest jobs. Perfectly balanced. Weight, 5¾ lbs. Right—the "Take About" Surfacer for wood, metal, plastics, stone, etc. Three sizes: 9, 14, and 23 lbs. Made by Porter-Cable Machine Co., Syracuse 8.



BUILD IT LIGHTER, SMALLER, BETTER-LOOKING, WITH

R & M MATCHED MOTOR PARTS

press. Thermostatically-controlled heating elements have range of 250 to 500 F. Machine has 3-in. stroke, is 10-in. high, and weighs 2 lb. Plastics Development Corp., New York.

BENCH SHAPER. For toolroom and industrial use, 7-in. shaper has cutting speeds 3 to 114 fpm. Stroke rates of 42, 75, 120 and 195 per minute are obtained by shifting V-belt on 4-step cone pulley. Tool head has 3-in. feed; work table is 5 7/16 by 5 by 6-in. Reversible power cross-feeds range from 0.002 to 0.016 in. per ram stroke. Machine powered by 1/3-hp, 1725-rpm motor. South Bend Lathe Works, South Bend, Ind.

TOOL GRINDER. For free-hand grinding of tools. Will handle rough, semifinish and finish grinding. Uses 8-in. vitrified wheel for roughing; 6-in. diamond or vitrified wheel for finishing. Powered by ¾-hp, 3450-rpm reversible motor; includes electrically driven coolant pump. Floor space, 44 by 30 in. Willey's Carbide Tool Co., Detroit, Mich.

BELT GRINDER. For grinding, polishing and deburring of production work. Includes double-sealed, preloaded ball bearings in precision bored seats, dynamically balanced arbor pulleys, aluminum oxide belts in 4 grits. Delta Mfg. Div. of Rockwell Mfg. Co., Milwaukee, Wis.

TUBE END FINISHER. For automatic, air-operated deburring, center drilling, rod chamfering, drilling, reaming, pointing or boring of tubing in sizes to 2-in. diameter. Will handle 800 to 1200 tube ends per hour. Vertical mounting base optional permitting gravity unloading of parts. Foot-switch operated air cylinder control leaves operator's hands free to handle work. Pines Engineering Co. Inc., Aurora, Ill.

AUTOMATIC SPECIAL-PURPOSE MACHINE. For processing 32 holes every 45 seconds in cast iron alloy, 6-cylinder engine block. Machine counterbores 6 exhaust valve insert holes, reams inlet valve passages, counterbores hole for plug, and countersinks 19 holes. Clamping is hydraulic, with automatic work cycle. Snyder Tool & Engineering Co., Detroit, Mich.

SURFACE GRINDER. Hydraulically operated table feed; 8 by 24-in. capacity. For tool room or production line work. Three spindle speeds, 1750, 2200 and 2600 rpm. Table speeds to 90 fpm. Uses 12-in. wheel powered by 2-hp motor. Interchangeable quill type spindle, elevation handwheel at apron, sim-

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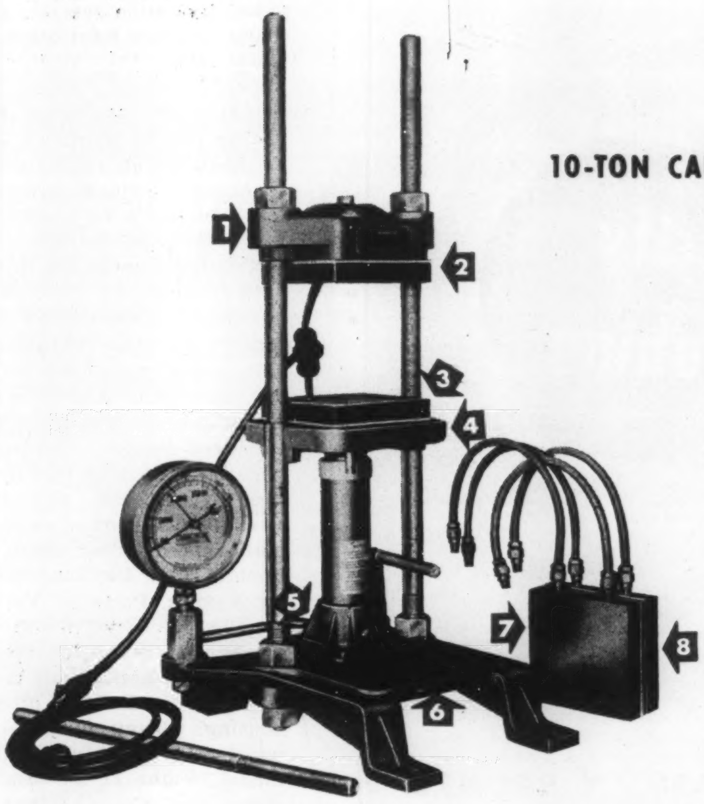


10-TON CARVER LABORATORY PRESS

1, 4, 6 Frame Parts: Head, Moving Platen, and Base.

2, 3 Electric Hot Plates for temperatures to 600°F.

5 Hydraulic Cylinder Unit Base for operation at 16,000 psi.

7, 8 Steam Hot Plates for intermittent use with steam to 200 lbs. and cold water.

Precision Equipment Demands Dependable Meehanite® Castings

Fred S. Carver, Inc., New York, N. Y., manufacturers of the Carver Laboratory Press illustrated make extensive use of Meehanite castings in the construction of their various press units. The castings are indicated, and quickly reveal the superior engineering properties which must be provided in order to meet the design specifications.

Note the hydraulic cylinder unit which is designed for repeated operations at 16,000 psi. Note also the electric hot plates which must maintain their dimensional stability after repeated submission to temperatures up to 600° F.

These units were designed for and have been built with Meehanite castings for many years, and thousands of them are giving trouble-free service all over the world. This is another example of the proper combination of good design plus the specification of Meehanite castings for better components, providing regularly the correct combination of engineering properties.

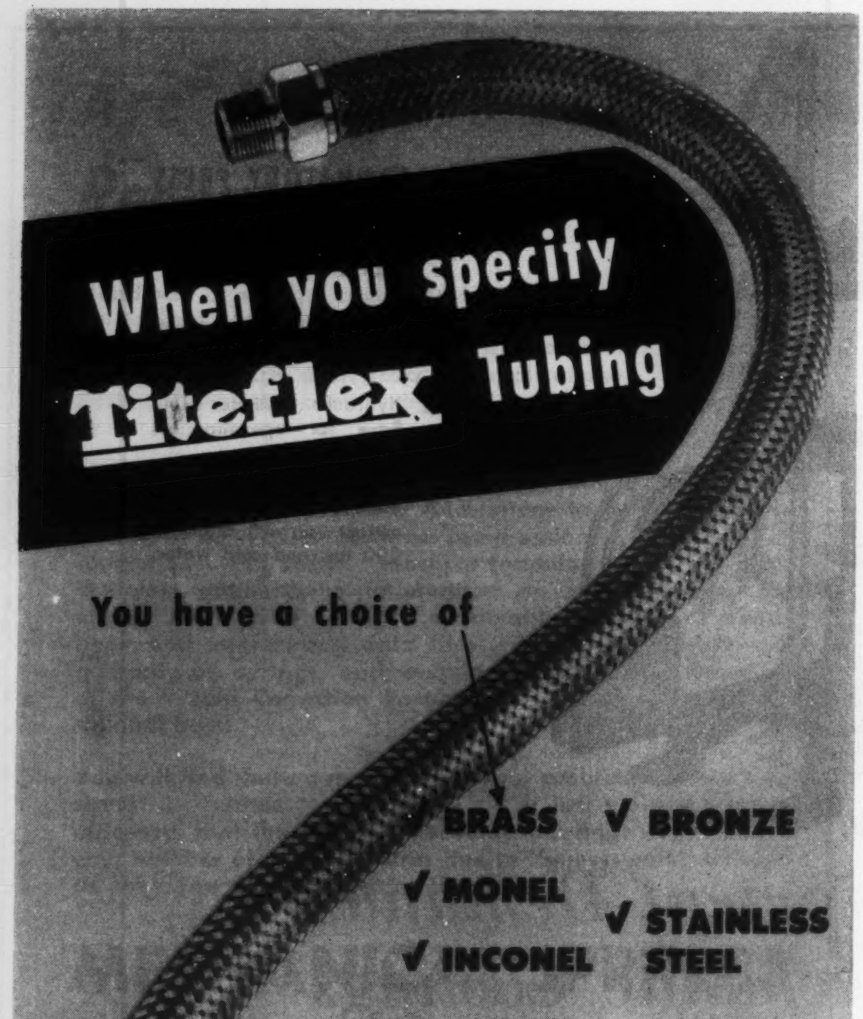
We have a Bulletin 30 entitled "Meehanite Means Better Castings" which describes a series of similar production and specification problems solved through the use of Meehanite castings. For a copy write to any of the foundries listed.

MEEHANITE FOUNDRIES

American Brake Shoe Co.	Mahwah, New Jersey
The American Laundry Machinery Co.	Rochester, New York
Atlas Foundry Co.	Detroit, Michigan
Banner Iron Works	St. Louis, Missouri
Barnett Foundry & Machine Co.	Irvington, New Jersey
H. W. Butterworth & Sons Co.	Bethayres, Pennsylvania
Continental Gin Co.	Birmingham, Alabama
The Cooper-Bessemer Corp.	Mt. Vernon, Ohio and Grove City, Pa.
Crawford & Doherty Foundry Co.	Portland, Oregon
Farrel-Birmingham Co., Inc.	Ansonia, Connecticut
Florence Pipe Foundry & Machine Co.	Florence, New Jersey
Fulton Foundry & Machine Co., Inc.	Cleveland, Ohio
General Foundry & Manufacturing Co.	Flint, Michigan
Greenlee Foundry Co.	Chicago, Illinois
The Hamilton Foundry & Machine Co.	Hamilton, Ohio
Johnstone Foundries, Inc.	Grove City, Pennsylvania
Kanawha Manufacturing Co.	Charleston, West Virginia
Koehring Co.	Milwaukee, Wisconsin
Lincoln Foundry Corp.	Los Angeles, California
The Henry Perkins Co.	Bridgewater, Massachusetts
Pohlman Foundry Co., Inc.	Buffalo, New York
Rosedale Foundry & Machine Co.	Pittsburgh, Pennsylvania
Ross-Meehan Foundries	Chattanooga, Tennessee
Shenango-Penn Mold Co.	Dover, Ohio
Sonith Industries, Inc.	Indianapolis, Indiana
Standard Foundry Co.	Worcester, Massachusetts
The Stearns-Roger Manufacturing Co.	Denver, Colorado
Traylor Engineering & Mfg. Co.	Allentown, Pennsylvania
U. S. Challenge Co.	Centerville, Iowa and Batavia, Illinois
Valley Iron Works, Inc.	St. Paul, Minnesota
Vulcan Foundry Co.	Oakland, California
Warren Foundry & Pipe Corporation	Phillipsburg, New Jersey
E. Long Ltd.	Orillia, Ontario
Otis-Fensom Elevator Co., Ltd.	Hamilton, Ontario

"This advertisement sponsored by foundries listed above."

Meehanite® NEW ROCHELLE, N. Y.



Regardless of the nature of the gas or liquid to be handled, you can choose a TITEFLEX all-metal flexible tubing of the required corrosion resistance. For TITEFLEX tubing is furnished with innercore made of brass, monel, inconel, bronze or stainless steel to assure satisfactory performance over a wide temperature range and under practically all conditions where corrosion is encountered. TITEFLEX also offers a wide choice of materials for braiding and fittings.

Remember, too, that TITEFLEX is constructed entirely of metal—with no packing to wear away or disintegrate. Play safe, specify TITEFLEX ALL-METAL flexible tubing for replacements and for new installations.

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plified hydraulic system, and automatic pressure lubrication included. Covel Mfg. Co., Benton Harbor, Mich.

WIRE MARKING MACHINE. For color coding plastic insulated wire. Will spiral-stripe up to 3 colors simultaneously on plastic-covered or any other similar wire. Machine capacity; 3/64 to 0.2-in. wire diameter. Wire speeds up to 200 fpm possible with proper ink. James L. Entwistle Co., Pawtucket, R. I.

VERTICLE SANDER. Portable; weight, 8 lb and 7 oz; overall height, 7 in. Air operated. Also designed for use as grinder with cup type, counter-bored center wheels and cup wire brushes. Free speeds of 4500, 5500, 6000, 7200, and 8500 rpm available. Governor assures constant speed under load. Buckeye Tools Corp., Dayton, Ohio.

DISK SANDER. Portable. Verticle type spindle driven by 110-volt ac-dc universal motor at 5200 rpm no-load speed. Side handle can be attached to right or left side of aluminum housing. Heavy duty 7-in. model weighs 10 lb; standard duty 9-in. model weighs 11 lb. Bradford Machine Tool Co., Cincinnati.

INTERNAL GRINDER. For grinding special internal tapers on parts such as machine tool spindles and special axles. Double-chuck workhead is moved longitudinally to position work for grinding. Sine bar attachment provides taper control. *ID*, *OD* and face can be ground at one chucking. Workpiece will index 180 degrees to assure concentricity when both ends of piece are to be ground. Workhead can be replaced by fixture allowing spindles to be ground in their own bearings. Bryant Chucking Grinder Co., Springfield, Vt.

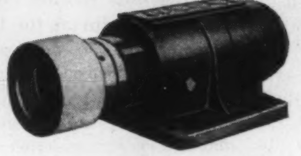
DRILLING AND TAPPING MACHINE. Drills, countersinks and taps sixteen 7/16-20 holes per cycle in automotive upper control arm assemblies. Drill head carrying 16 spindles has 10-in. stroke, 0.009-in. per min. feed, 60 sfpm drill speed. Taps with speed of 40 surface feet per minute are staggered on tap head to reduce power load. Machine produces 788 pieces per hour at 87½ per cent efficiency using 3-station indexing head. Snyder Tool & Engineering Co., Detroit.

CYLINDRICAL SUPERFINISHER. For grinding small parts such as plug gages, hydraulic cylinders, pistons, and shafts. Capacity; 12 in. between centers, 8½-in. swing with 3-in. max working diameter, and 100-lb workpiece weight. Variable spindle speed of 40 to 1000 rpm. Spring-loaded quill pressure adjustable from 0 to 45 lb. Attach-

Put These POPE PRECISION SPINDLES To Profitable Use

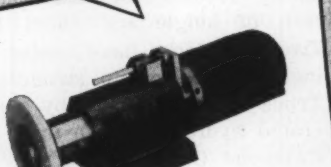
Your grinders and other machine tools will do more and better work when they are equipped with these skilfully designed, precision made, *sealed package* Spindles.

P-32T—This POPE Sealed Motorized Spindle is recommended for all makes of 6" x 18" surface grinders. It has sealed-in 1 HP motor and sealed lubrication, SKF super-precision, double row roller bearings. It assures finer finishes and greater production.

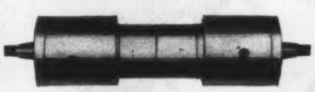


P-2514—This POPE Motorized Spindle with sealed lubrication is recommended for a broad range of grinding, milling and boring applications. It runs in any position from horizontal to vertical. It comes in sizes from ¾ to 20 HP, 900 to 3600 RPM.

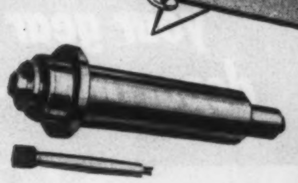
P-1—This POPE Belt-driven, Cartridge Type Surface Grinder Spindle with sealed-in lubrication fits standard grinders. It operates at speeds up to 6000 RPM. It gives long, dependable service.



P-2652—This POPE Direct Motorized Cartridge Type Spindle with 1 HP, 3450 RPM totally enclosed motor is equipped with mounting bracket with provision for 3" of precise endwise adjustment.



P-274—This POPE Double-Ended Tool and Cutter Grinder Spindle with sealed lubrication employs twin belt pulley center drive at speeds up to 6000 RPM. Fits standard grinders.



P-3521—This POPE Internal Grinding Spindle is adapted to mount Jarno taper interchangeable extension arbors to cover a broad range of service. The 1" series shown on page 3 of Data Sheet No. 7 will fit this spindle.

For complete specifications and estimates on any or all of these Spindles get in touch with

No. 60

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LOOK for this EXTRA on the motors you buy
PROTECTED
REBUILT MOTOR
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MOTOR EXCHANGE PLAN

General Electric is happy to announce that the motor exchange plan which proved so successful with fractional-hp motors has been extended to cover integral-hp Tri-Clad motors. 16 Motor Exchange Centers are prepared to make an immediate exchange of Tri-Clad open (dripproof) motors (popular types, 4-pole, 1 to 5 hp) during the first five years of service. How the new plan works to reduce machine down time and motor replacement costs is told in Bulletin GEA-5189 (for motor users) and Bulletin GEA-5180 (for machinery manufacturers). SEND FOR YOUR FREE COPY to *Apparatus Department, General Electric Company, Schenectady 5, N. Y.*

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ments available include motor-driven traverse and centerless-roll drive attachment for parts having no centers. Gisholt Machine Co., Madison, Wis.

AXLE BORING MACHINE. Bores and faces 3 types of automotive axle housings without changing machine setup. Capacity, 280 parts per hour at 100 per cent efficiency. Axles loaded at first station; bored and faced at second station with machine automatically adjusting for various length parts through electric eye system; and sorted onto one of two conveyors, depending on subsequent processing, at third station. All-hydraulic feeds and automatic pushbutton controlled cycling included. Cross Co., Detroit.

PLATE NOTCHING UNITS. Capacity, 5 by 5-in., 90-degree corner notch in ¼-in. mild steel plate. Self-contained units suitable for use in many setups in stamping press and press brake work. Wales-Strippit Corp., North Tonawanda, N. Y.

DRILLING AND TAPPING MACHINE. Drills, chamfers, tap-drills, and taps hole for adjusting worm in wrenches in 5 seconds. All 4 operations performed simultaneously using 6-station indexing dial. Tap-drilling operation divided between 2 stations to reduce drilling time and chip removal problem. Govro-Nelson Co., Detroit.

Materials Handling

LIFT TRUCK FOR CABLE REELS. Capacity, 1000-lb reels. Built on pattern of single-face pallet truck. Two base forks have center opening wide enough to straddle reel. Truck is elevated 5 in. by hand-operated hydraulic pump unit. Lyon-Raymond Corp., Greene, N. Y.

CLAMP TRUCKS. For handling of bulky items such as drums, barrels, boxes, etc. Hydraulically operated clamp arms grip load for lifting and transporting. Hydraulic system of truck supplies power to operate clamp cylinders. Baker Industrial Truck Div. of Baker-Raulang Co., Cleveland, O.

Plant Equipment

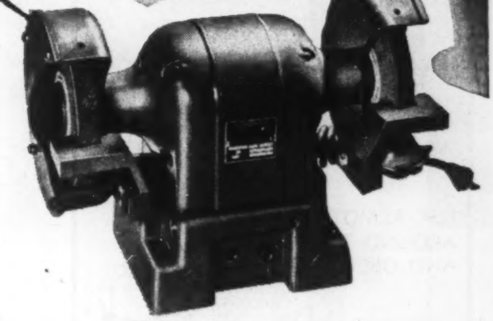
HYDROSTATIC PRECIPITATOR. For collection and control of dust generated in manufacturing processes. Cleans air by combined action of centrifugal force and inter-mixing of air and water. Capacity; 48,000 cfm. Can be operated from 50 to 120 per cent of rated capacity with no loss in efficiency. American Air Filter Co. Inc., Louisville, Ky.

COOLING TOWER. Capacity, 7½ tons. Unit features motor driven fan, all steel construction, nail-less re-

fewer parts.. less labor

SIZE — 5¾" x 6¼" x 4¼"
WEIGHT — 3 lb, 14 oz
WALL THICKNESS — .198" avg
CORING — Most holes are cored — a few are tapped
STRENGTH OF THE ALLOY —
Over 40,000 psi tensile
Over 40 ft-lb impact — ¼" square bar
(Strength values determined on test bars)

another successful product designed for ZINC DIE CASTING



The use of zinc die castings for the motor end housings, the tool rests and the base of the Black and Decker bench grinder shown at the right greatly reduces machining and assembling time. By any other method of production, either a greater number of parts would be required, or machining costs would be excessive.

Take a look at the above zinc die cast motor end housing—two of them are used on each bench grinder. How else could this complex shape—with all of the integral assembly bosses and cored recesses — be produced economically? By designing specifically for die casting production, the weight of this housing has been minimized through the use of comparatively thin sections (see tag on casting) for an application of this type. Ample strength is assured by the judicious location of ribs on the inside walls of the casting.

This bench grinder is just one of many successful applications for zinc die castings in the field of small tools. Typical applications in other major industries will be covered in future advertisements in these pages.

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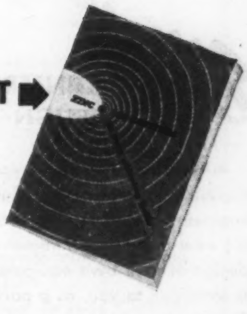
This new booklet has 64 pages of photographs depicting zinc die castings in the assembly of a wide variety of products in many fields. Send for your copy today!



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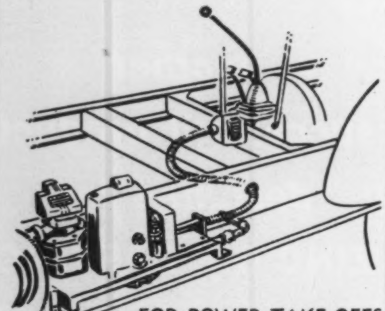

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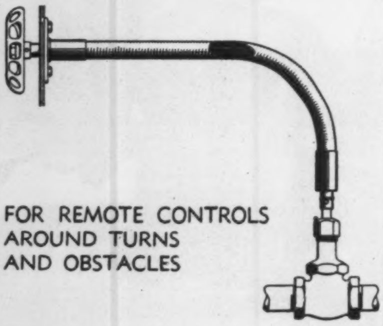

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217 PROSPECT AVE. BINGHAMTON, N. Y.

movable redwood filling and is suitable for indoor or outdoor installation. Marley Co. Inc., Kansas City, Kans.

Testing

TENSILE TESTING MACHINE. Electronic controlled machine for obtaining accurate load-elongation measurements of plastics, textiles, wire, paper, rubber, etc. Capacity, 2 grams to 5000 lb. Jaw speeds, 0.02 to 20 in. per minute. Weighing system uses strain gage principle for detecting and recording load applied. Pulling jaw drive provides controlled rate of elongation of sample. Recorder automatically makes load-elongation curves at constant rate of elongation. Operation of pulling head pushbutton controlled, can be made automatic through adjustable, close-tolerance switches. Instron Engineering Corp., Quincy, Mass.

MICRO HARDNESS TESTER. Applies dead weight of 1 to 1000 grams for use with Knoop indenter or Vickers type indenter. For micro hardness testing of minute particles, thin metals, wire, foil, ceramics, glass, enamels, plastics, and jewels. Bench type, hand operated to obviate motor vibration. Adjustable dash pot controls speed of load application and time of load retention. Optical measuring equipment included. Kent Cliff Laboratories, Peekskill, N. Y.

HYDRAULIC DYNAMOMETERS. For accurate load-testing of motors. Capacities, 30 to 300 ft-lb torque. Adapters are provided for various shaft sizes. Tests possible include idle, pull-in, pull-out, full load, and locked. Torque is read directly from gage on dynamometer. Wagner Electric Corp., St. Louis, Mo.

Woodworking Equipment

PORTABLE ELECTRIC SAW. Six-in. saw for general duty. Depth of cut adjustment accurately regulates between ⅛ and 2 in. Designed for one-hand operation, with trigger switch in handle. Fan draws air through motor and discharges it at front, blowing dust off line of work. Idle speed, 5500 rpm; load speed, 3200 rpm. Length, 10 in.; width, 8⅛ in.; height, 9⅜ in. Porter-Cable Machine Co., Syracuse, N. Y.

RADIAL SAW. Capacity, 3⅛ in. cut with 9-in. blade. Offset yoke permits all cuts to be made in the convenient table area. Geared motor has 2½-times overload capacity. Crosscut travel, 24 in.; table size, 46 by 24 in. In 1½-hp single or 3-phase units. Walker-Turner Div., Kearney & Trecker Corp., Plainfield, N. J.

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That delivers More than the Goods!

The MITCHELL-BRADFORD "Package" delivers far more than a range of proven metal finishes, heat treating materials and metal cleaners. It gives you an all-inclusive service for setting up and maintaining the most efficient metal finishing and heat treating operations known to modern chemical engineering.

BLACKENING PROCESSES FOR METALS
BLACK MAGIC for Steel and Iron
BLACK MAGIC for Zinc, Zinc plate, Zinc die castings and Cadmium Plate
BLACK MAGIC for Copper and its Alloys

METAL CLEANERS
Cleaner #7 Still, soak cleaner
Cleaner #9 Heavy duty soak cleaner
Cleaner #12 Reverse current cleaner
Cleaner #20 Non-etching Aluminum Cleaner
Cleaner #30 Etching-type Aluminum Cleaner
Cleaner #25 Brass Cleaner (non-oxidizing)
Cleaner #66 Solvent Cleaner (emulsion type)
Special Cleaners — formulated for specific applications

HEAT TREATING MATERIALS
QUICK-CARB, #20 — #40 — #60, Liquid Bath Carburizing Salts.
QUICK-TEMPER TEMPERING AND DRAWING SALTS — 275°F. and 420°F. Melting Points.
NEUTRAL SALTS — For Complete Range of Temperatures.

PROTECTIVE FILM FINISHES
WITCH-DIP, Wax Base Compound
WITCH-OIL, Water Displacing Corrosion Inhibiting Oil
FINISH No. 146, Hard Protective Coating and Paint Bond
SILCO — An inorganic, low-temperature bake, vitreous type finish. Rust, acid and abrasion resistant. All colors.

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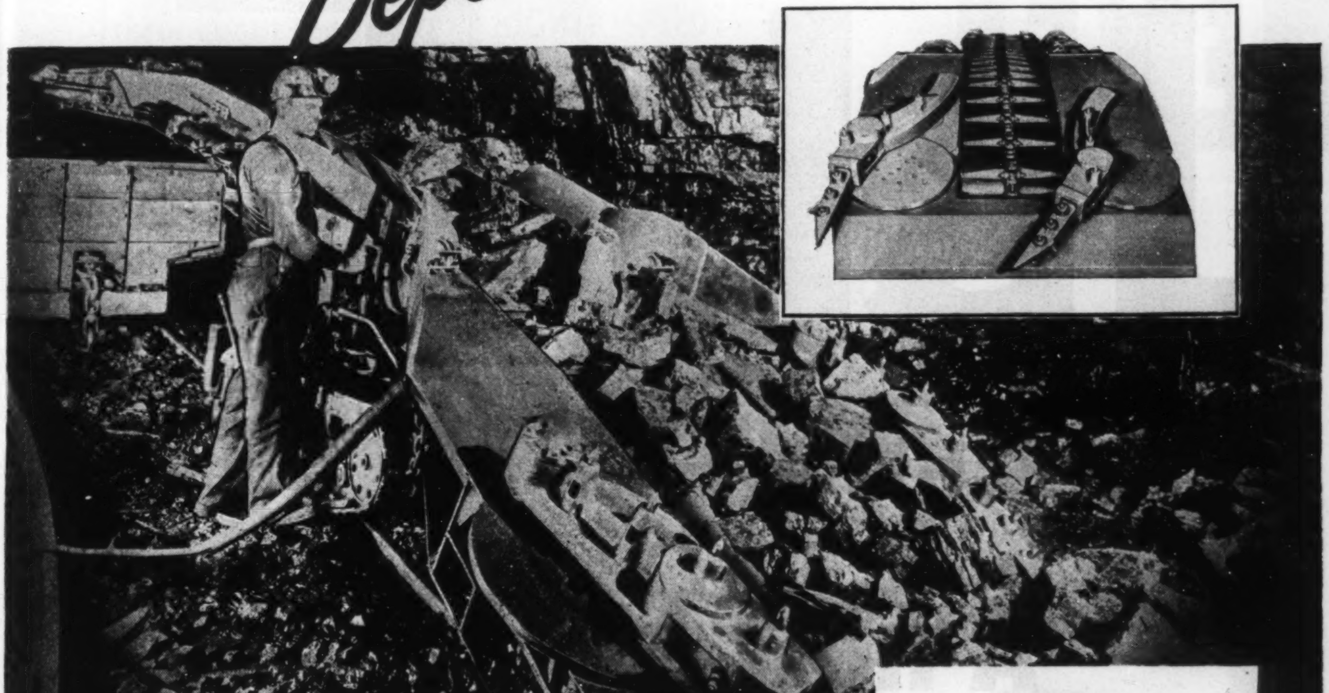
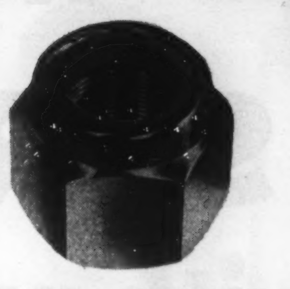
SELF-LOCKING "Grip-Dependability" PREVENTS OPERATIONAL FAILURES





THE FAMOUS RED ELASTIC COLLAR IS VISIBLE EVIDENCE OF LOCKING SECURITY

Threadless and permanently elastic, it provides these 4 outstanding features:

1. Protects against nuts loosening due to VIBRATION
2. Keeps locking threads CORROSION FREE
3. Provides for accurate BOLT LOADING
4. Seals against LIQUID LEAKAGE along the bolt threads

—*the Red Elastic Collar absorbs heavy-duty reciprocating action* SHOCK! VIBRATION!

The slam of the Joy Loader gathering arms, as they force coal onto the conveyor, creates the kind of pounding vibration that loosens ordinary fasteners . . . and seriously affects loader performance. Elastic Stop Nut application points like those on the conveyor chain flights, and the teeth of the gathering arms, are critical spots. Here dependable bolted connections are a MUST — connections that will retain their grip under this terrific vibration . . . shock . . . impact . . . and will prevent costly, time-consuming operational failures.

Elastic Stop Nuts are the answer! The self-locking, self-sealing Red Elastic Collar of these nuts provides the "grip-dependability" Joy needs to keep their precise settings permanent... no amount of shock or vibration can shake these nuts loose.

Going ahead one more step, Joy gives their customers further protection against fastener failure. They install Elastic Stop Nuts on electrical connections — parts of vital importance for proper loader operation.

In addition, Elastic Stop Nuts keep bolt and nut threads rust-free, seal against liquid seepage along bolt threads, do not damage the threads, and are re-usable.

HERE'S A CHALLENGE: Send us complete details of your toughest bolted trouble spot. We'll supply test nuts—FREE, in experimental quantities. Write: Elastic Stop Nut Corporation of America, Union, N. J. Representatives and Agents are located in many principal cities.

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TRADE MARK

ELASTIC STOP NUTS

HIGH TENSILE · ANCHOR · WING · SPLINE · CLINCH · GANG CHANNEL · NYLON CAP

OVER 450 TYPES AND SIZES IMMEDIATELY AVAILABLE FROM STOCK

Another outstanding J&L development—

J&L "E"

FREE-CUTTING STEEL

A new bessemer SCREW STOCK with proved machinability ratings as high as 170!

- Backed by 50 years of leadership in the field of free-machining, cold-finished steels.
- Proved by exhaustive field testing.
- J & L "E" Free-Cutting Steel is made in *three* grades: E-15, E-23 and E-33, each within the composition limits of the standard bessemer screw steels and with similar tensile properties.

Note the following equivalents:

E-15 - equivalent standard grade, B-1111
E-23 - equivalent standard grade, B-1112
E-33 - equivalent standard grade, B-1113

J&L STEEL

Forty-five independent machine shops, throughout the metal-working industry, have tested over *6,100 tons* of J & L "E" Steel in more than 100 applications. These shops report:

BETTER MACHINE FINISH

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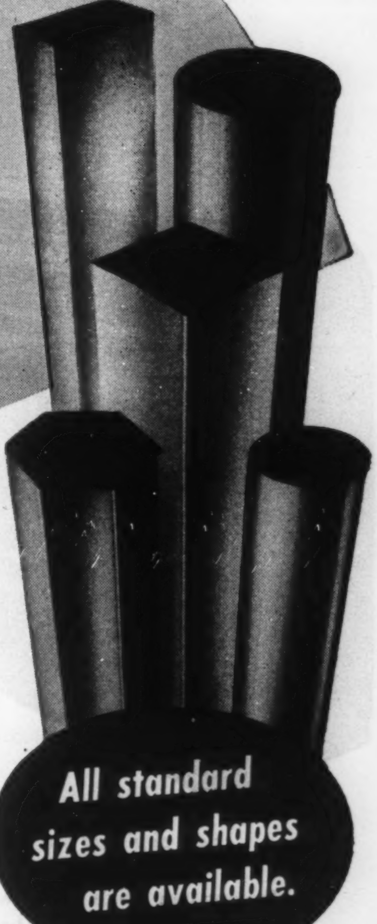
HIGHER SPEEDS

MACHINABILITY RATINGS UP TO 170

BETTER RESPONSE TO FORMING AND COLD WORK

HIGHER MAGNETIC PERMEABILITY



All standard sizes and shapes are available.

For 50 years J&L has led in the development of free-cutting, cold-finished steels—both bessemer and open-hearth. Every new J&L steel introduced in this field has been a major contribution toward the lowering of the unit cost of machined steel parts. Now we offer you J&L "E", a bessemer grade steel with distinctly greater free-cutting efficiency.

During the development of J&L "E" Steel, at least four years were spent proving its qualities, in the field, under a great variety of machining conditions. In the course of our investigations, J&L metallurgists have accumulated considerable data and a large number of case histories. Therefore, we say with assurance that J&L "E" free-cutting steel opens the door to new production economies you never thought possible.

You will want complete information on this latest J&L steel development. Let us discuss the money-saving possibilities of J&L "E" Steel with you. The coupon is for your convenience.

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410 Jones & Laughlin Building
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I should like to have more information on J&L "E" Free-Cutting Bessemer Screw Stock. Please have your representative call.

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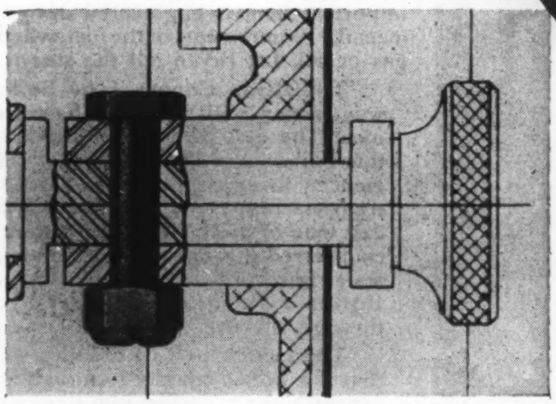
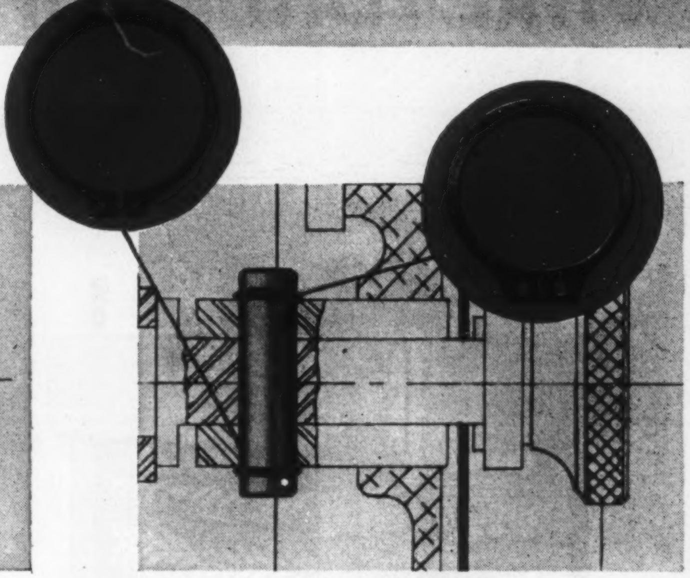


OLD WAY

Special ¼" cap screw and ¼-28 fibre-insert nut holds idler arm and pulley assembly on Model A3 "Take-About" Sander, Porter-Cable Machine Company.



NEW WAY

Simple ¼" C.R. shaft, grooved in automatic screw machine, equipped with Waldes Truarc Retaining Rings. Bowed external ring (#5101-25) at top exerts resilient pressure taken up by Standard external ring (#5100-25) at bottom. Assembly is secure against vibration, can be easily taken apart and re-installed many times with same Truarc rings.

Every sander through the production lines costs 9 cents less for materials, requires 5 minutes less labor—with just the simple change from cap screw and nut to Waldes Truarc rings by Porter-Cable Machine Company, Syracuse, New York. The change to Truarc required no new design, no alterations in castings, but just the reappraisal of old methods.

Truarc can help you cut costs and increase production, too. Wherever you use machined shoulders, nuts, bolts, snap rings, cotter pins—there's a Truarc ring that does a better job of holding parts together. All Waldes Truarc Retaining Rings are precision engineered, remain always circular to give a never-failing grip.

Send us your drawings. Waldes Truarc engineers will be glad to show how Truarc can help you.

TRUARC
engineering specifications and data

WALDES

TRUARC

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RETAINING RINGS

WALDES KOHINOOR, INC., LONG ISLAND CITY 1, NEW YORK

WALDES TRUARC RETAINING RINGS ARE PROTECTED BY U. S. PATS. 2,302,948; 2,026,454; 2,416,852 AND OTHER PATS. PEND.

Waldes Kohinoor, Inc., 47-10 Austel Place MD-5
Long Island City 1, N. Y.

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Business Address__________

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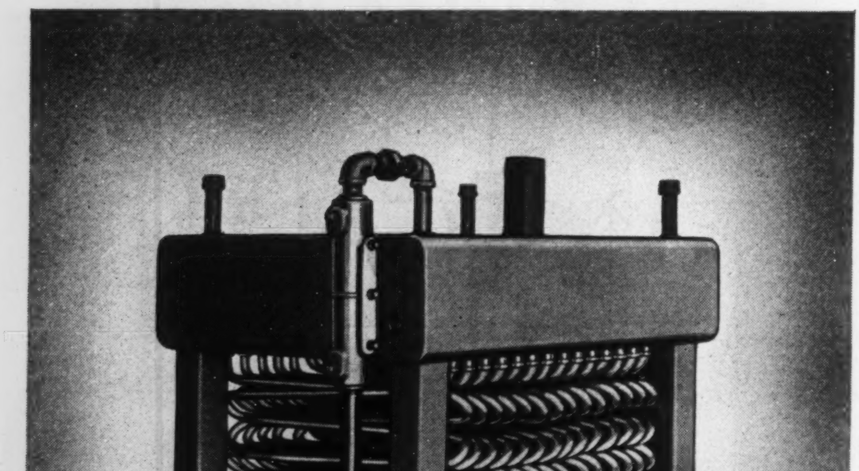
COPPER TUBE

A VITAL FEATURE OF BRYAN BOILERS



Bryan Steam Boiler with housing removed, showing copper tubes. Bryan claims 75 pounds of steam in 15 min. from cold start, due to high heat conductivity of the Revere tubes. Also made in low-pressure and hot water models.

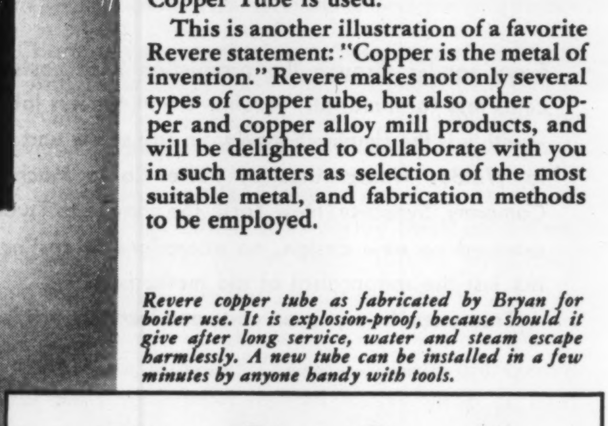
THE big feature of the boilers made by the Bryan Steam Corp., Peru, Indiana, is that they use copper tubes. Another important item is engineered design to meet the requirements of the fuel, whether gas or oil. Let Bryan tell the story:

> "The Bryan Copper Tube Boiler was started with a double-barreled idea. The first part of the idea was that boilers could be made more efficient by using copper tubes. Copper transfers heat many times as fast as cast iron or steel. Heat from a fire is transferred through copper tubes to water in record time, and in a Bryan Boiler with minimum heat loss through the flue due to the design.
>
> "The second part of the idea was that if a boiler could be engineered expressly for gas or oil, the economy of operation would be such as to revolutionize the heating industry."

The first Bryan Boilers were a sensation when offered over 20 years ago. Today they are made in a number of sizes, from domestic types to 50 hp high-pressure units for industrial uses. Revere Copper Tube is used.

This is another illustration of a favorite Revere statement: "Copper is the metal of invention." Revere makes not only several types of copper tube, but also other copper and copper alloy mill products, and will be delighted to collaborate with you in such matters as selection of the most suitable metal, and fabrication methods to be employed.

Revere copper tube as fabricated by Bryan for boiler use. It is explosion-proof, because should it give after long service, water and steam escape harmlessly. A new tube can be installed in a few minutes by anyone handy with tools.



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Close tolerances in resilient gaskets are seldom necessary

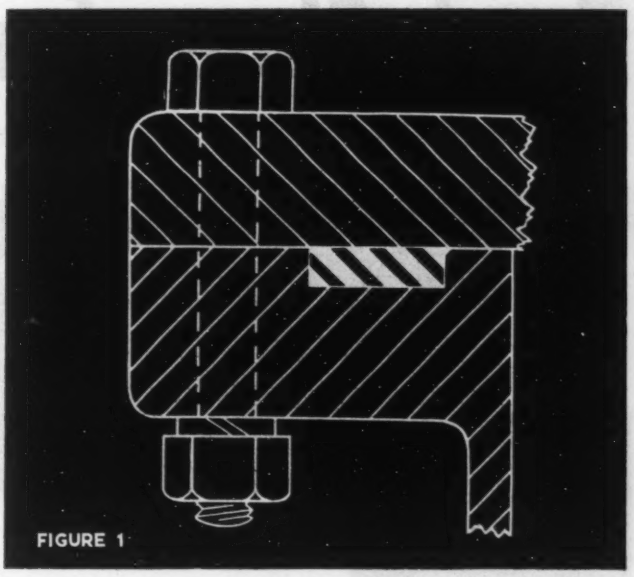

FIGURE 1

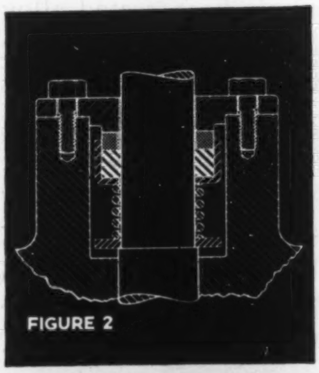

FIGURE 2

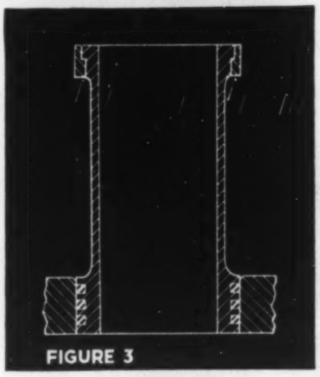

FIGURE 3

Close tolerances in resilient gaskets are a luxury that is seldom justified. Even units with extremely close assembly tolerances can usually be sealed with gaskets made to commercial standards . . . provided the design of the unit and the choice of gasket material are in harmony.

In figure 1, for example, close assembly tolerances can be maintained. Yet the gasket can vary over a relatively wide range of thicknesses if it has been cut from a truly compressible material like Armstrong's cork-and-rubber. Because these materials decrease in volume under load, they compensate for tolerance variation.

When rubber was used as a packing ring in figure 2, close tolerances were necessary to prevent high radial pressure. A factory-lubricated cork-and-rubber ring was substituted. Made slightly undersize to insure a tight seal, cork-and-rubber compresses enough to maintain low radial pressure.

To seal the cylinder liner in figure 3 with molded rubber rings, extremely close tolerances were required. Undersize rings leaked. Oversize rings tended to split the sleeve. A slightly oversize cork-and-rubber ring was tried. Fitting snugly into the groove, it sealed tightly. And there was no danger of splitting the sleeve.

Available in 17 different formulations, Armstrong's cork-and-rubber combines truly compressible cork particles and non-compressible synthetic rubbers in a wide range of compressibilities. To suit particular sealing requirements, these gasket materials may be used with compressions ranging from 10% to 50%.

Versatile cork-and-rubber can help solve your sealing problems. We recommend that you discuss your application with an Armstrong representative. He can suggest suitable materials and supply samples for experimental use.

Send for this Gasket Handbook

You'll find useful application and specification data in the new, enlarged 24-page booklet, "Armstrong's Gasket and Sealing Materials." It contains up-to-date data on synthetic rubber, cork-and-synthetic-rubber, cork composition, and fiber sheet sealing materials.

This booklet includes ten technical discussions of the factors influencing modern gasket and joint design. It also suggests methods of putting Armstrong's stock materials to specialized uses in such fields as radio, electrical, automotive, petroleum, and transportation industries. Also included are typical applications and current government specifications.

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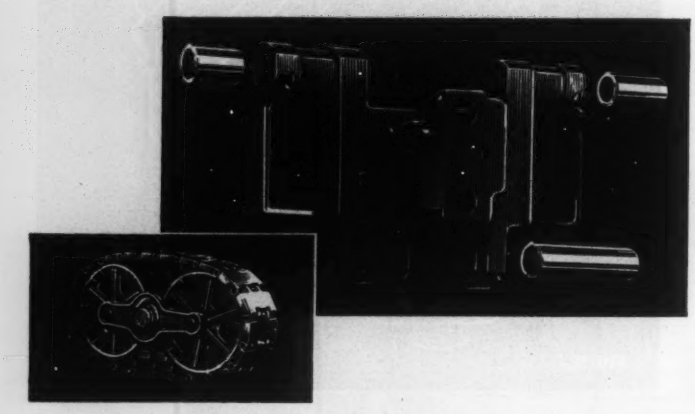
Track Shoes for a Heavyweight



SEE those crawler wheel track shoes on the unit behind the tractor? They carry heavy loads over rock, sand, clay, and gravel — through mud, snow, and water. That means every part has got to be super-tough—particularly the bushings that hinge the shoes together. Imagine the constant twist and strain, pound and jolt — the harsh grinding wear of tiny abrasive earth particles that these bushings must stand.

The Trackson Company, makers of these crawler units, brought this problem to Globe Steel Tubes Co. Globe made specific recommendations for a tough, heat-treated alloy steel tubing in a special self-locking lug shape to make these bushings. Result: the Trackson Company simplified production—bettered their product. If you have a design or a production problem—investigate tubing as a possible answer for minimizing machining, lowering cost, reducing weight, improving product performance. Write — Globe Steel Tubes Co., Milwaukee 11, Wis.

Photo — Courtesy of the Trackson Company, Milwaukee

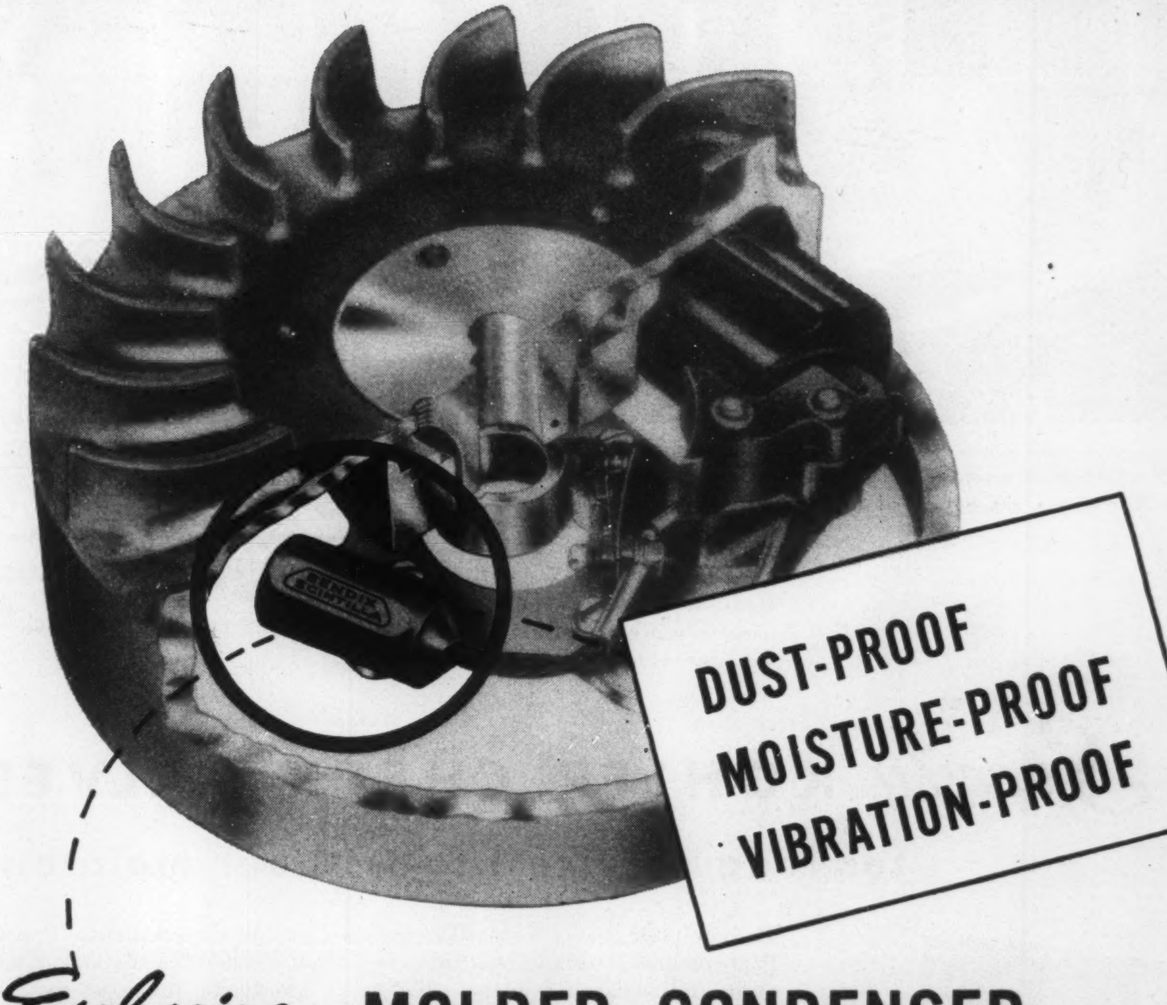
Globe Seamless Stainless Steel Tubes — Gloweld Welded Stainless Steel Tubes — Globe Mechanical Tubes — Globe-iron Seamless High Purity Ingot Iron Tubes — Globe Aircraft Tubes — Pressure Tubes — Carbon and Alloy Steel Tubes — Globe Welding Fittings.

GLOBE

STEEL TUBES

BENDIX-SCINTILLA FLYWHEEL-TYPE MAGNETO

FOR 1- AND 2-CYLINDER ENGINES



Exclusive MOLDED CONDENSER

The exclusive Bendix-Scintilla molded condenser is just the sort of progressive improvement you would expect from the organization which has brought so many far-reaching developments to the ignition field. With the new Bendix-Scintilla process, the condenser and its support bracket are plastic molded, under high vacuum, into one vibration, moisture and dust-proof unit. In this way chronic condenser problems are licked before they have a chance to start. This is only one of the many modern features in Bendix-Scintilla Flywheel-type Magnetos that assure greater dependability, longer service life for your products. Write today for complete information.

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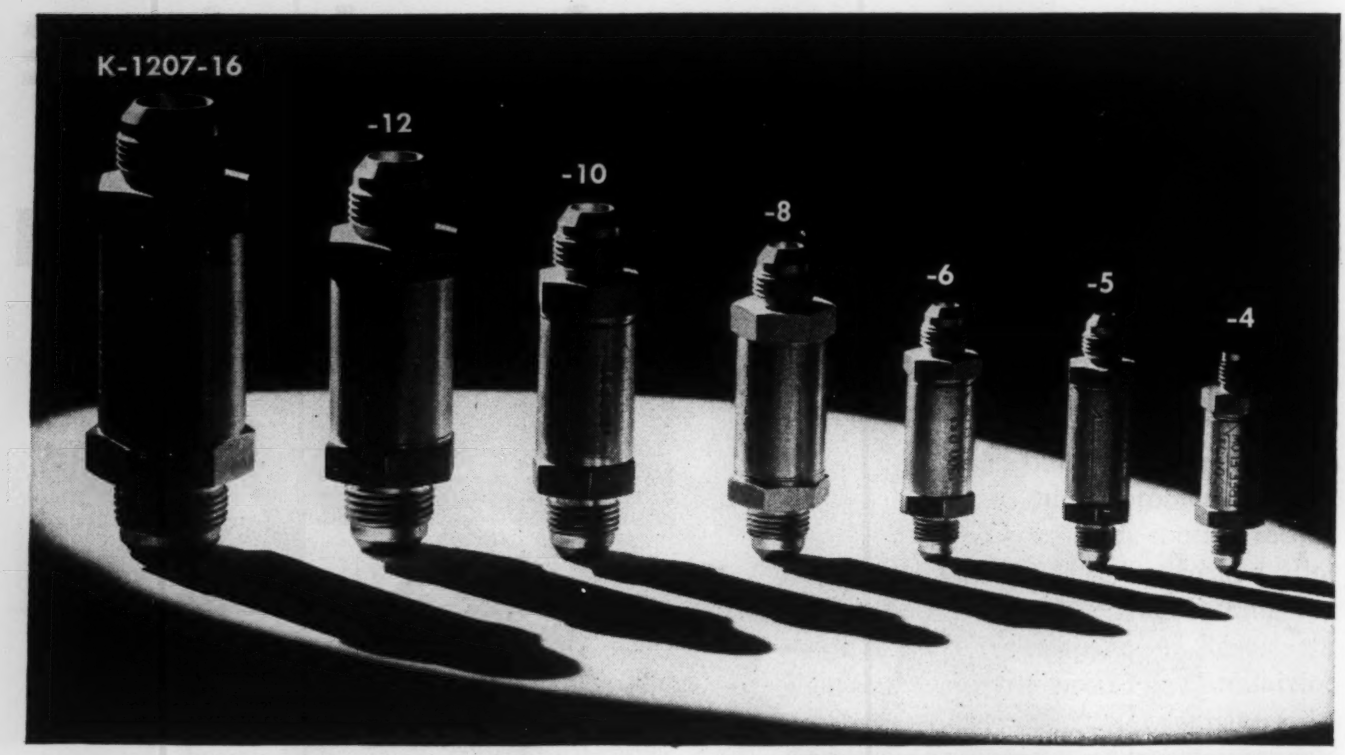
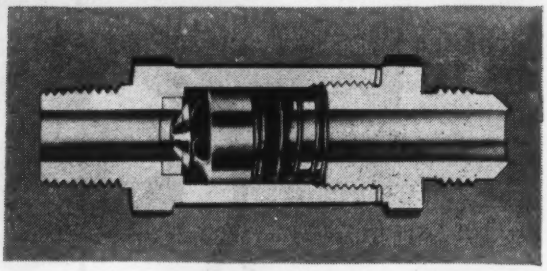


Cone-type check valves illustrated have an operating pressure up to 1500 PSI with a burst pressure of 3750 PSI. Excellent for use with hydraulic fluids, gasolines, oils, water, and acids non-corrosive to aluminum.



Metal-to-metal seats are best suited for high pressures, extreme temperatures, and corrosive fluids.

Specify KOHLER CHECK VALVES

for long service life without maintenance

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Precision Parts
KOHLER-KOHLER

The complete line of Kohler Precision Parts includes check valves for all aircraft, industrial and automotive installations. Leading manufacturers specify Kohler valves for lines using hydraulic fluids, gasolines, lubricating oils, aromatic fluids, air, vacuum, water, acids, chemicals, etc.—and requiring a *pressure regulating valve, pressure relief valve, vacuum breaker, restrictor check, check valves with high or low opening pressures or check valves for special applications.*

All major types, cone, soft seat, and swing checks, have been developed to meet rigid service requirements. The superiority of Kohler designs and precision manufacturing processes have been demonstrated by valves in actual use. Kohler valves have quick opening and positive closing without poppet chatter or leakage. When they are open, free flow is maintained with minimum pressure drop.

Kohler engineers will gladly cooperate in developing precision parts for your special requirements. Write for our new catalog, showing the full line of Kohler Precision Parts, with specifications, engineering data and useful information.

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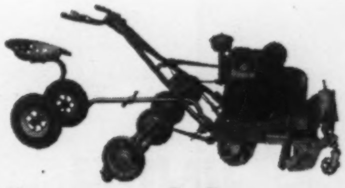
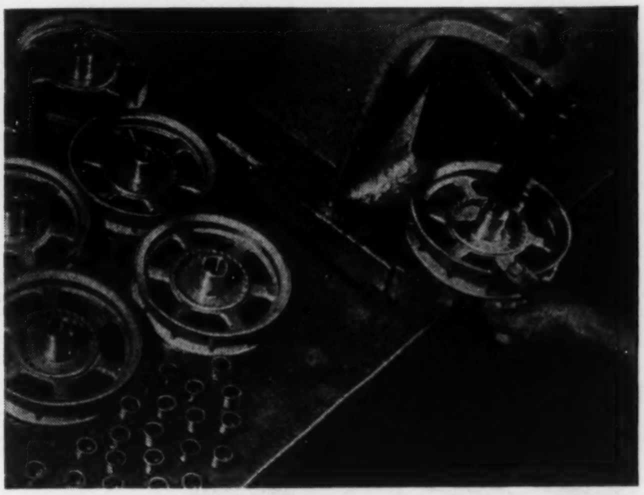
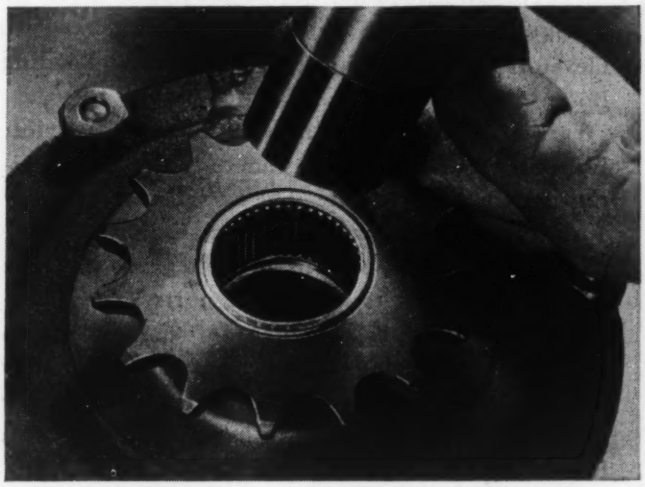
Torrington Needle Bearings Reduce Friction, Simplify Design for Coldwell-Philadelphia Lawn Mowers



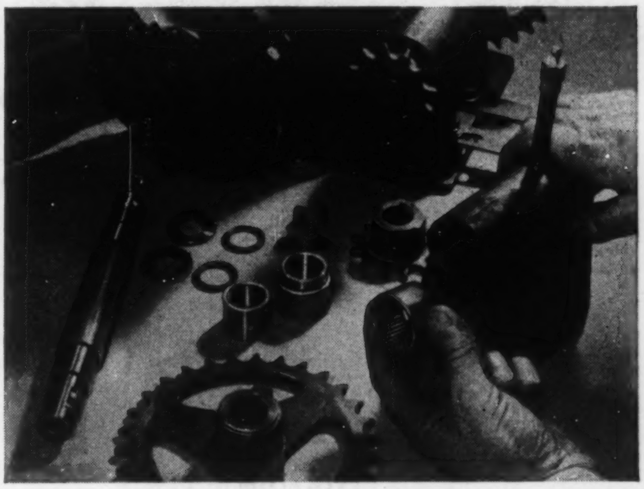
Power requirements are reduced by the smooth anti-friction operation of Torrington Needle Bearings in mowers built by Coldwell-Philadelphia Lawn Mower Company. Needle Bearings also provide high radial capacity to take the shock of rough service.



Quick, easy installation of Needle Bearings in mower wheels cuts assembly costs. Only a plain machined bore is required for a housing. No snap rings, shoulders or other retaining devices are needed. These Needle Bearing features mean simplicity and economy.

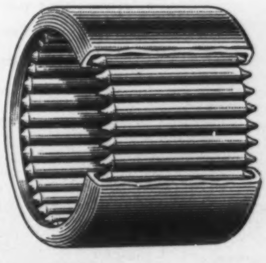


Lubricant is retained over long periods of service by the close-fitting, turned-in lips of Needle Bearings. In the gang unit cutter clutch gear, above, this construction also helps exclude moisture and dirt. Long service life is secured with minimum maintenance.



A space-saver indeed! A large main clutch shaft is supported in a relatively small housing, thanks to the compactness of Needle Bearings. This construction, plus the tremendous load capacity of these anti-friction units, means a lighter, sturdier mower.

You can gain the benefits of anti-friction operation in a space-saving and weight-saving design with Torrington Needle Bearings. Our engineers will be glad to help you adapt these high-capacity units to your requirements. Write us today. THE TORRINGTON COMPANY, Torrington, Conn., or South Bend 21, Ind. District offices and distributors in principal cities.



TORRINGTON *NEEDLE* BEARINGS

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Farval saves $9600 in one year

on world's largest Marcus drive

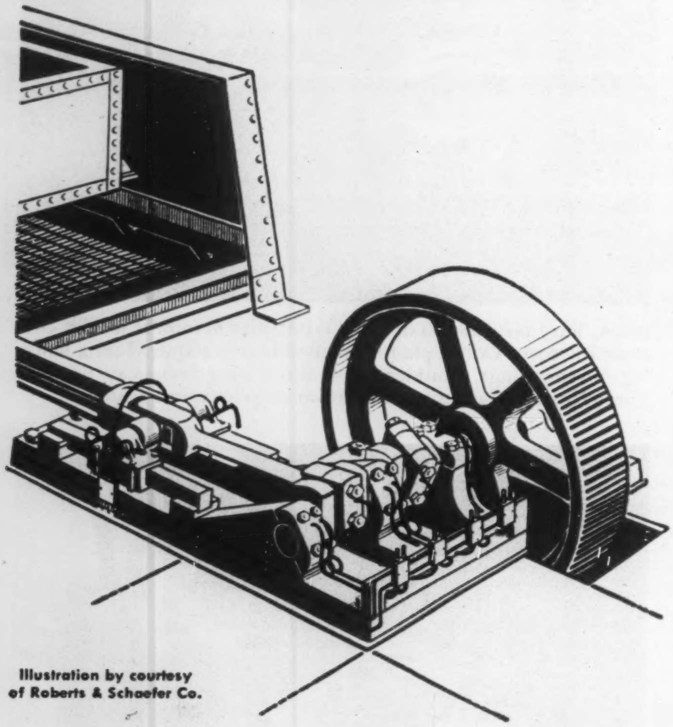


Illustration by courtesy of Roberts & Schaefer Co.

FARVAL—*Studies in Centralized Lubrication*
No. 108

TWO men used to spend all their time lubricating the drive of the world's largest Marcus shaker screen, located in a West Virginia tipple. They had to use an expensive graphite grease, and it required 300 pounds a week to hold the bearings.

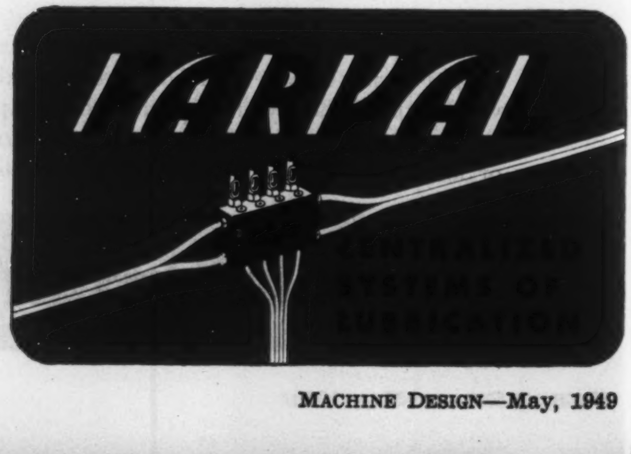
Finally, in order to relieve this situation, the company installed a Farval automatic centralized system of lubrication. They were able to cut off the two oilers, saving $160 a week. With Farval they were also able to use a much cheaper grease—and further, used only one-third as much, saving another $30 a week. Thus an annual dollar saving of more than $9600 was realized on labor and lubricant alone, not to mention the increased life of the bearings and the elimination of shutdowns and delays.

Farval centralized lubricating systems have been serving the coal industry for more than 17 years. In preparation plants, Farval lubricates Feeders, Crushers, Conveyors, Shakers, Vibrating Screens, Elevators, Washers, Jigs, Dryers, Mixers, Loading Booms and Drives.

Farval has proven itself in over 20 years of service. It is the original Dualine system of centralized lubrication that others imitate. The Farval valve has only 2 moving parts—is simple, sure and foolproof, without springs, ball-checks or pinhole ports to cause trouble. Through its wide valve ports and full hydraulic operation, Farval unfailingly delivers grease or oil to each bearing—as much as you want, exactly measured—as often as desired. Indicators at every bearing show that each valve has functioned. For a full description, write for Bulletin No. 25.

The Farval Corporation, 3265 East 80th Street, Cleveland 4, Ohio.

Affiliate of The Cleveland Worm & Gear Company, Industrial Worm Gearing. In Canada: Peacock Brothers Limited.



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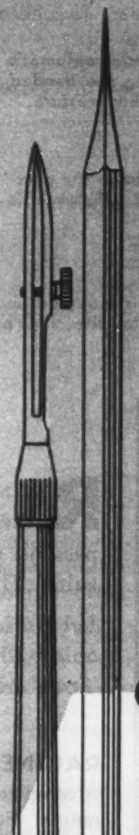

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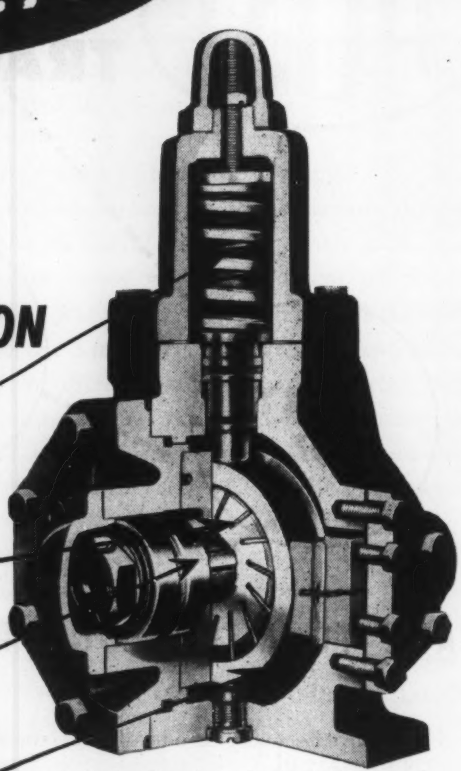
REDUCED OPERATING COSTS
QUIET, TROUBLE-FREE OPERATION



1 Spring governor provides automatic volume control, supplying only the needed flow of oil at a pre-determined pressure.

2 Tilted vanes cannot seize or gouge the pressure chamber ring. Constant efficiency is maintained.

3 Heavy duty pump shaft is mounted in anti-friction bearings for long life and power saving operation.

4 Pressure chamber ring of special alloy steel is automatically traversed between side plates to vary oil delivery.

COMMON APPLICATIONS FOR RACINE HYDRAULIC EQUIPMENT

- Presses
- Machine Tools
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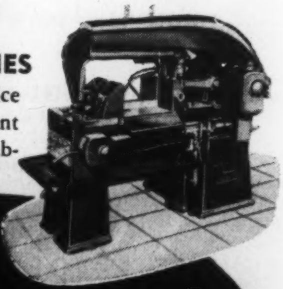
RACINE pumps will simplify your circuits. By-pass and relief valves with the accompanying extra piping are eliminated. Since RACINE pumps by-pass no oil, heating is reduced. Horsepower is saved. Quieter operation results. These features reduce installation cost and operating expense.

Let Racine hydraulic engineers review your applications. This service is available without cost or obligation. Write today, ask for catalog P-10-C. RACINE TOOL AND MACHINE COMPANY, 1773 State Street, Racine, Wisconsin.

RACINE *Hydraulic* METAL CUTTING MACHINES

A complete line in capacities 6″ x 6″ to 20″ x 20″ — in all price ranges. Features are simple. One lever control — open front design — progressive feed for cutting any metal from light tubing to tough tool steels. Write for Catalog No. 12.



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RACINE

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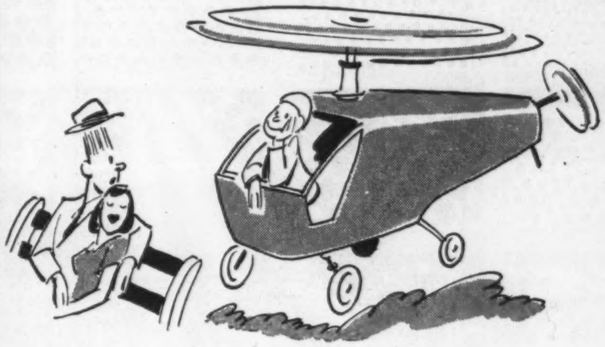
V-Belts can do the darndest things!

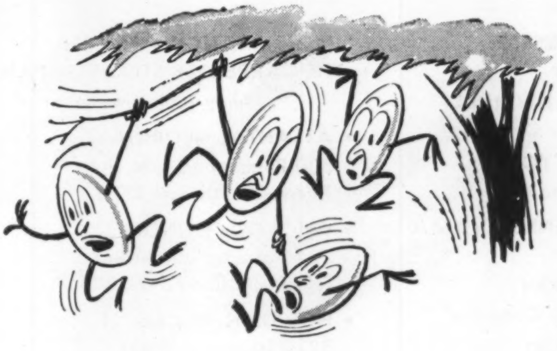
MILK A COW. Milking machines use controlled vacuum and gentle fluctuations to get the milk. Most manufacturers use V-Belts to drive the compressor.

WHY V-BELTS? Because they ignore the deteriorating effects of dirt, dust, moisture and animal acids present in every barn. What's more, milking machines must be compact. V-Belt drives permit the use of shorter centers, smaller pulleys. Save weight and space.



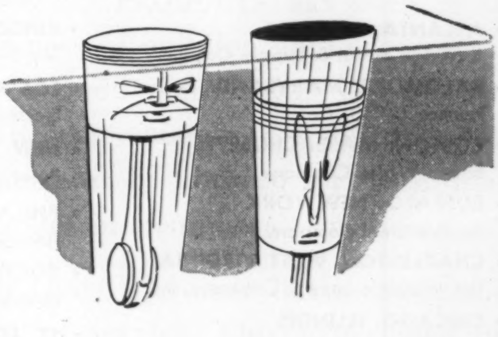
FLY A HELICOPTER. An aviation engineer has recently designed a helicopter that uses V-Belts to transmit the power from the engine to the rotors.

WHY V-BELTS? Because they are one of the most efficient methods of transmitting power known. They won't slip or stall. They are light, long wearing, easy to maintain. And they eliminate shafts, gearing and expensive machining.



SHAKE NUTS FROM A TREE. Raising nuts is big-time business. A leading pecan grower uses a steel cable and an eccentric drive (V-Belt driven) to gently shake the ripened nuts from the trees.

WHY V-BELTS? They absorb shock loads, withstand sudden power. They have a long service life, inexpensive. Operate anywhere with little or no maintenance.



KEEP TOLERANCES TO + or −.0001. When machine tool makers build machines that produce parts held to absolute tolerances, they depend on V-Belt drives to transmit the power.

WHY V-BELTS? Because V-Belts won't vibrate. They start and run smoothly. Absorb the shocks of sudden starts or overload.

WHAT HAVE YOU DONE WITH V-BELTS?

All of the above are drive applications design engineers have told us they have made using Dayton V-Belts. We share them with you in hopes they may help you in your work. We'd like, in turn, your experiences. If you have used V-Belts to solve an unusual problem and think it would help your fellow engineers, write and tell us. We'll be happy to publish it on this page, giving you full credit, of course.

WHAT WOULD YOU LIKE TO DO?

V-Belts have the happy faculty of making drives more efficient, or cheaper, or easier to maintain. Dayton engineers are skilled in how to use them. Dayton builds all kinds of V-Belts, for normal drives, high speeds, shortest possible centers, unusual conditions of heat, oil or static, and the like. They are available in all sizes. Write us your drive problem. We'll be happy to help you solve it. Address *The Dayton Rubber Company, Dayton 1, Ohio.*

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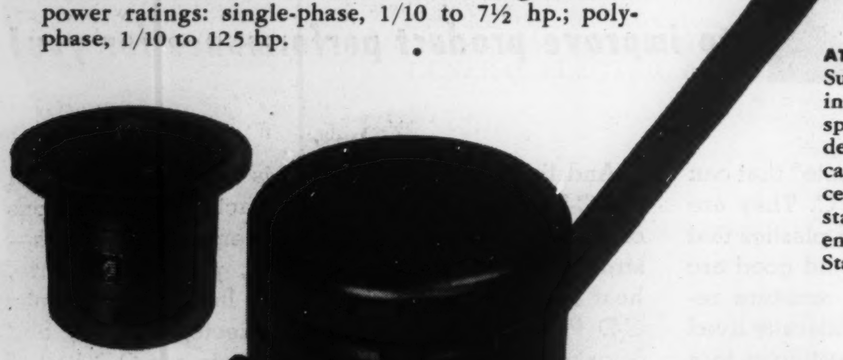
For all standard applications, SMITHway Electric Motors are built in both fractional and integral horsepower ratings: single-phase, 1/10 to 7½ hp.; polyphase, 1/10 to 125 hp.

ATLAS FLOOR MACHINE, product of Atlas Floor Surfacing Machinery Corp., New York City, incorporates a SMITHway Electric Motor specially designed for the job. To retain the designer's requirements for good appearance, capacitors and starting mechanism are concealed under the top cover, with a vertical starting-to-running-switch mechanism. The entire machine recently passed rigid United States Navy tests.



SMITHway ELECTRIC MOTOR used in the Atlas Floor Machine is shown in operating position and, upside down, to expose gear and breather cap. To reduce over-all height, top end bell is concave, and necessary polishing weight is provided. Cast-in terminal compartment included for 3 prong terminals. The motor has high torque, and is built for continuous-duty operation. It exceeds the machine designer's required electrical performance.

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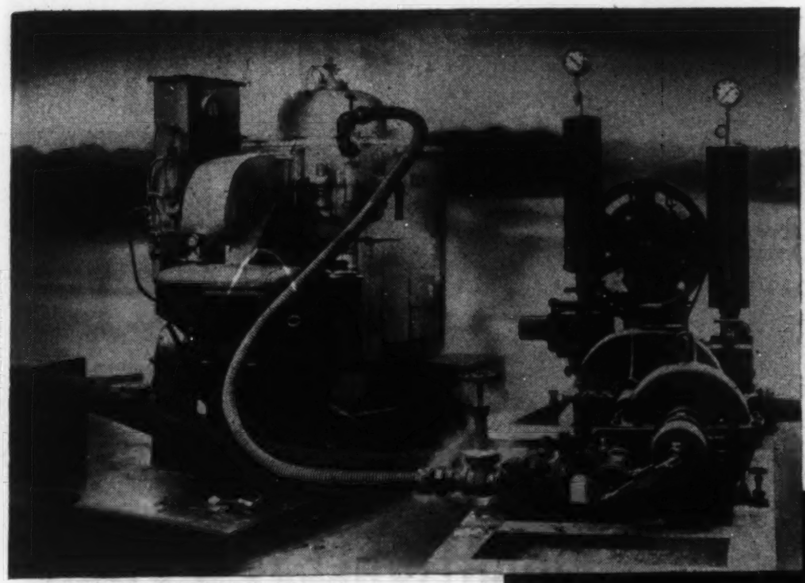

Heavy Duty Bettis Steamer Drives Turbo-Pump Through American Metal Hose

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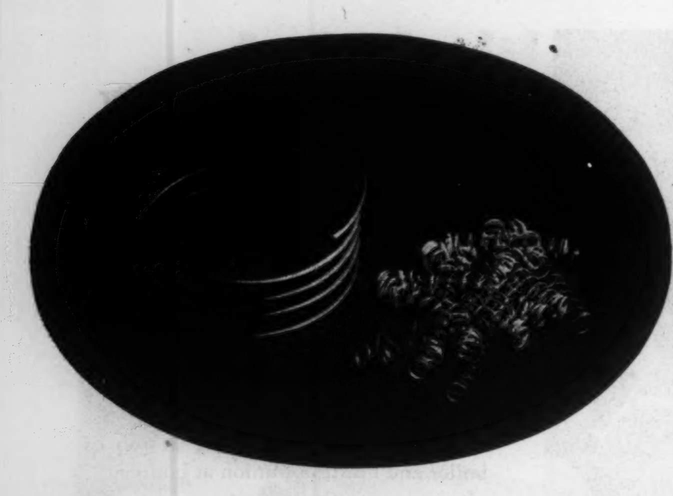

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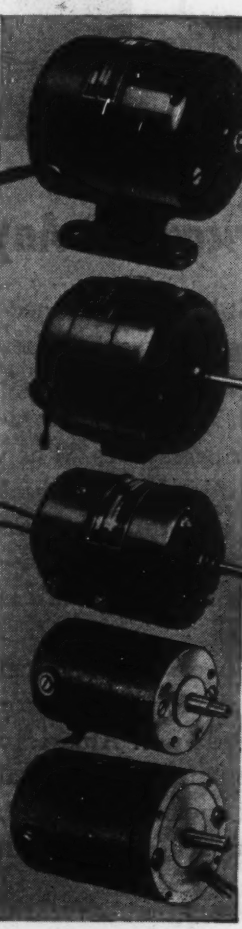

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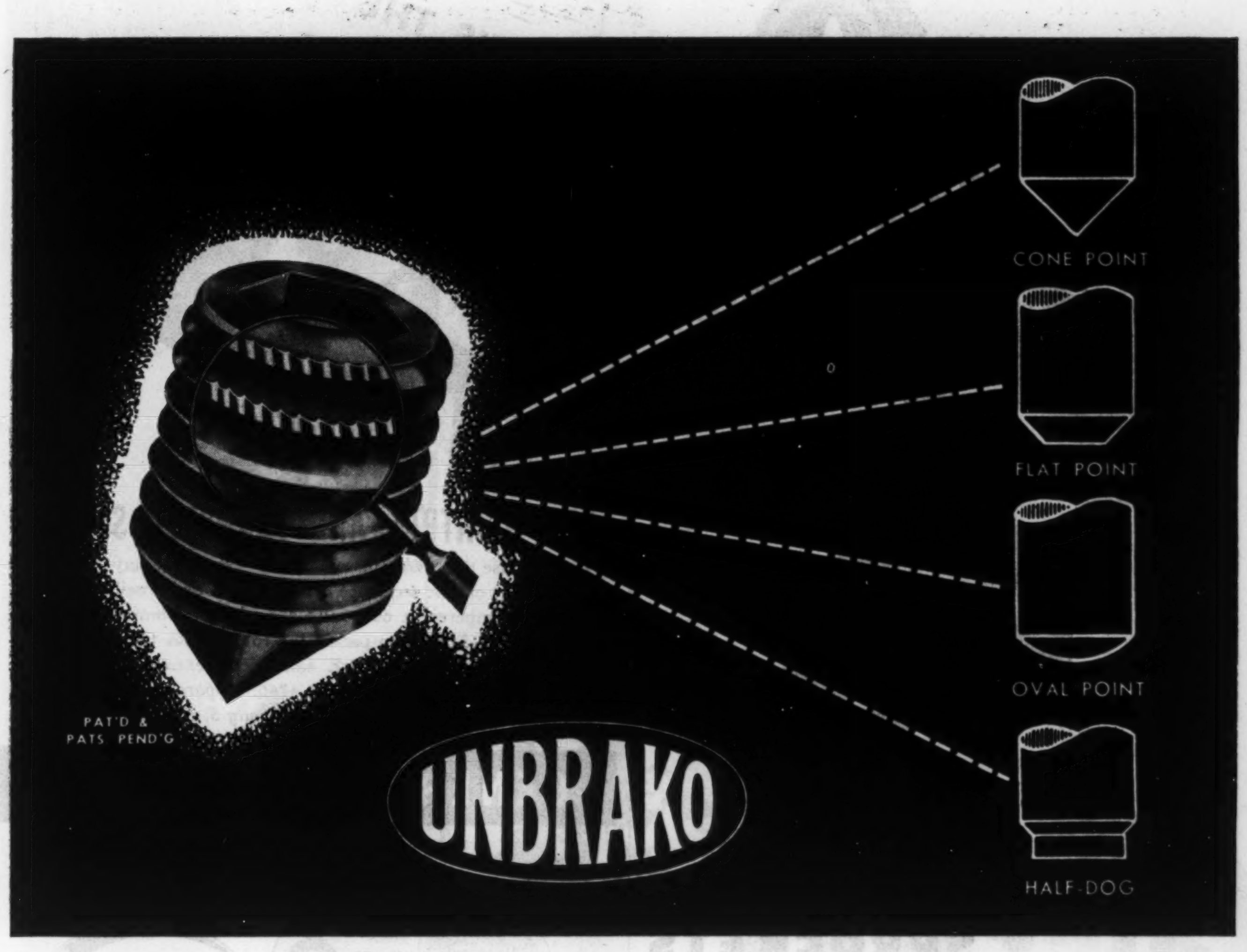

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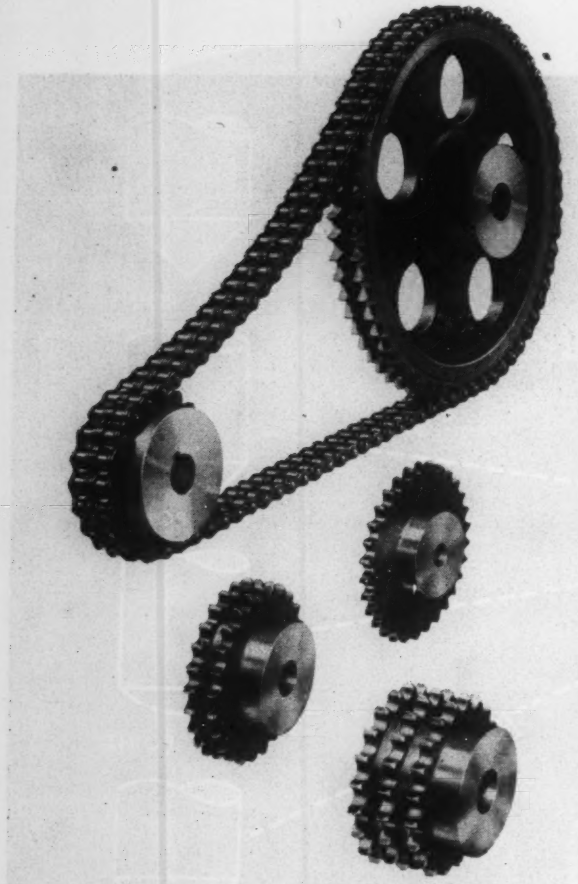

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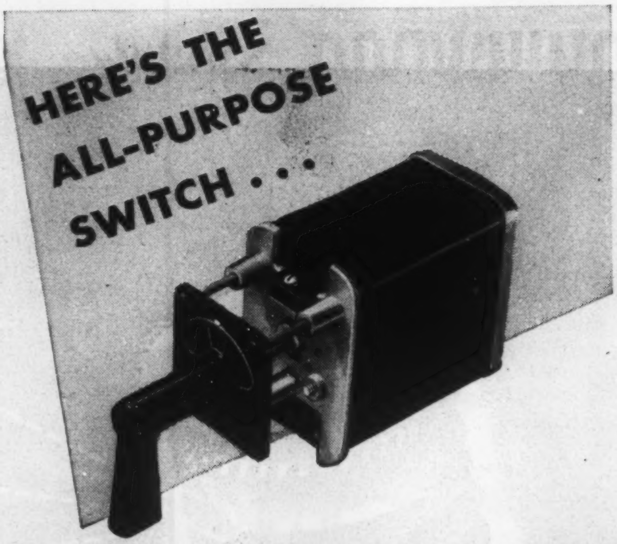

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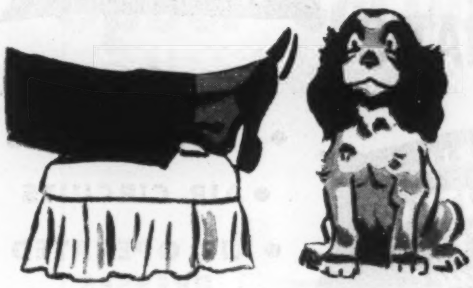

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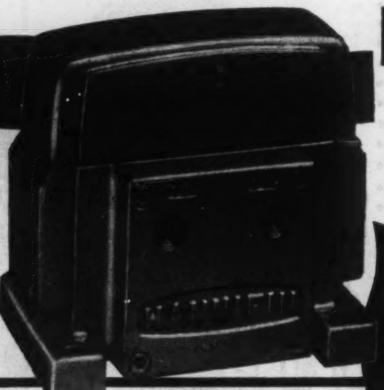

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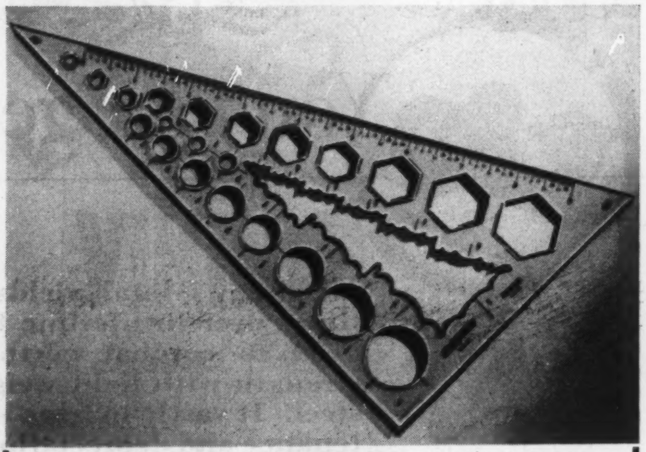

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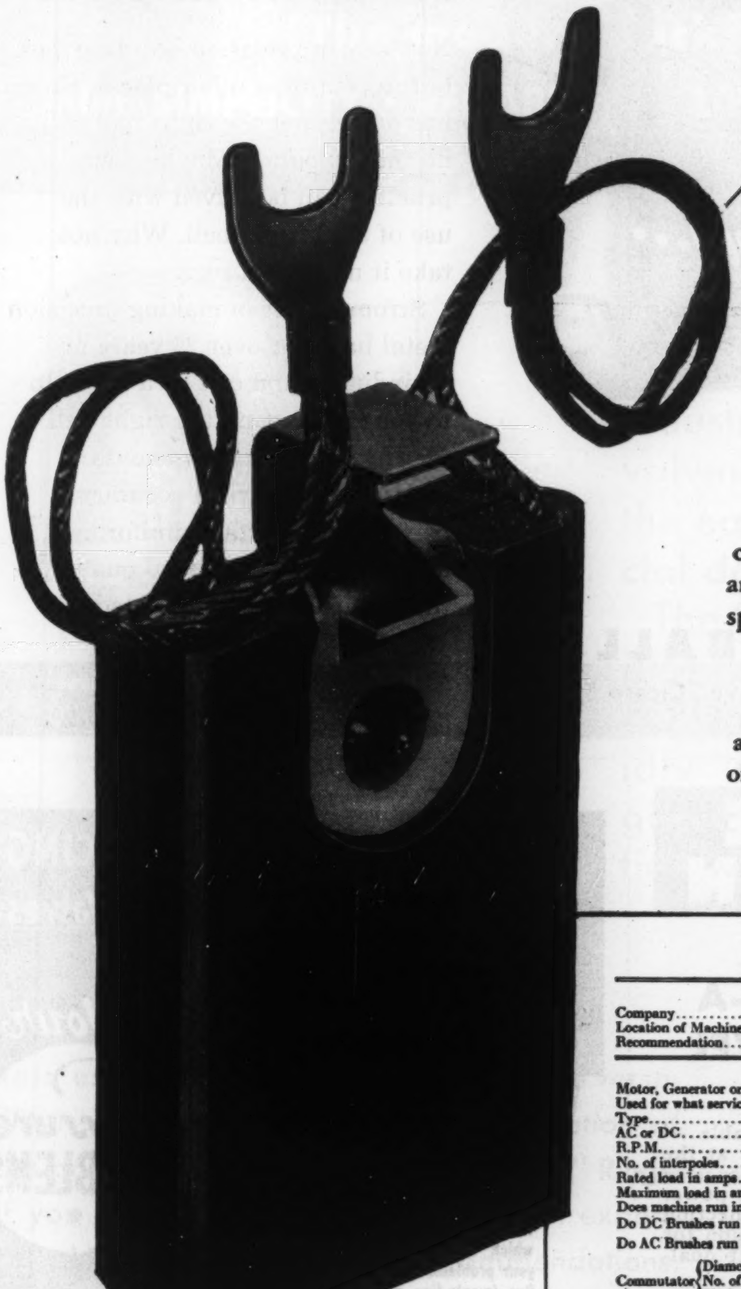
P. O. BOX 592, GLENDALE, CALIFORNIA

Speer carbon brushes



REFLECT

A Vast Accumulation of Performance Data

A half-century of experience analyzing local conditions influencing carbon brush performance, and the development of brush grades to eliminate specific difficulties, account for a vast accumulation of data at Speer Carbon Company laboratories.

Here, case histories and modern experimental and testing facilities are available for the analysis of your problems, whether they pertain to electric motor brush design, or maintenance. Write for the brush data sheet, shown below, for use in submitting your particular problem.

BRUSH DATA SHEET

GENERAL

Company....................Address....................
Location of Machine and Identifying No....................Brush Blue Print No....................
Recommendation....................Submitted by....................Date....................

DATA ON MACHINE

Motor, Generator or Rotary....................Built by....................
Used for what service....................
Type....................Form....................Serial....................Kv-a. or H. P....................
AC or DC....................Voltage....................Cycles....................Phase....................
R.P.M....................No. of main poles.....Do main poles have compensating windings?....................
No. of interpoles..........Are they series, shunt, compound or separately excited?....................
Rated load in amps....................Average load in amps....................
Maximum load in amps....................Duration of maximum load....................
Does machine run in one direction only?....................
Do DC Brushes run radial, leading or trailing?....................
Do AC Brushes run radial, leading or trailing?....................

Radial Leading Trailing

Commutator {Diameter.................... No. of segments.................... Flush or undercut mica....................}
Rings {Diameter.................... Number.................... Material....................}
Number of brushes per set, AC..........DC..........Spring pressure DC....................
Grade of brush now in use, AC..........DC..........Spring pressure AC....................
Are present brushes satisfactory?....................If not give details....................
....
....
....
Do brushes spark, glow, squeal or squeak?....................
Do brush faces show high polish, copper spots, etc.?....................
Is commutator or rings burned, roughened, worn or discolored?....................
Is there evidence of high mica?....................
Are there flat spots?....................
What grade or grades of brushes have worked successfully?....................
Remarks:....................
....

Speer

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ST. MARYS, PENNA.

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Licked
Many a Problem...

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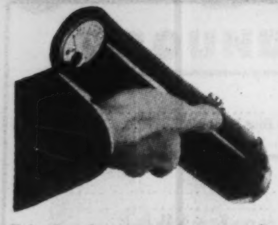

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Little larger than a flashlight and just as portable — simply point the Scott 410-A Sound Level Meter at the noise source and read the meter. An amazing advance in SLM design—entirely self-contained, no separate power source or microphone, unhampered by interconnecting cables, its accuracy fulfills ASA standards. Provision for remote mike, vibration pickup, etc. . . And Scott quality construction thru-out.

Range, 34-140 db. above ASA reference level. Humidity sealed crystal, diaphragm mike. Two-speed type meter. Simple recalibration. 11⅝ x 2½" diam.; weight 2 lbs., 7 oz. Net Price $249.00

. . . and VIBRATION-CHECK, too,
with the 410-X5 vibration integrator and 410-X6 calibrated vibration pickup. These accessories permit the 410-A sound level-meter to measure vibration from 25 to 3000 cycles at displacements of 0.14 micro-inches to 0.028 inches, velocities of 51.3 micro-inches/sec. to 10.3 inches/sec., and accelerations of 0.15 inches/sec./sec. to 3900 inches/sec./sec.
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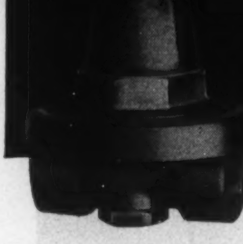

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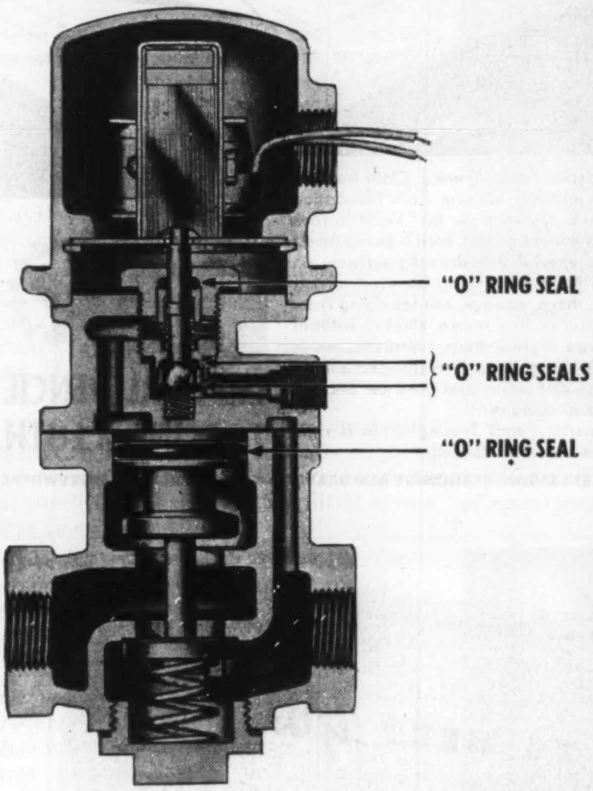
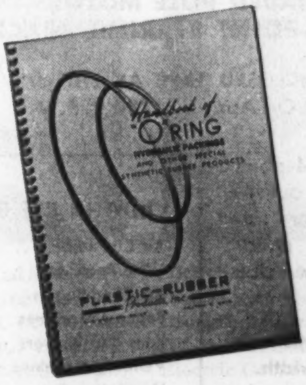


ROSS OPERATING VALVE COMPANY of Detroit, Michigan, the largest producer of industrial solenoid operated air valves, have used "O" Rings from the earliest stages of their commercial development.

The 3-Way in-line Pilot-type valve illustrated here uses a total of 4 "O" Rings. The "O" Ring on the rapidly moving poppet commonly gives 20,000,000 cycles of operation with no leakage or binding.



- Investigate "O" Ring Seals. Consult the "O" Ring specialists. Send for our "O" Ring Handbook. It's free.

Ross' experience is a good example of the versatility, satisfactory service and simplification of designs made possible by the use of "O" Rings. If you have a sealing problem call on experienced PRP field engineers for recommendations.

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Products, Inc.
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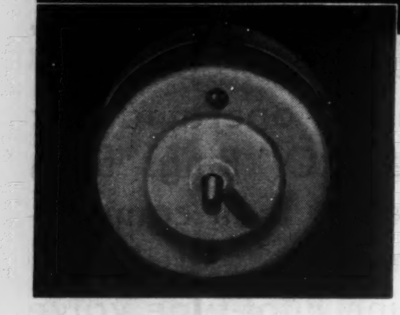

Skeleton view of our improved 4-pole Shaded Pole Motor showing the New 4-Point Bearing Bracket.

Same Motor Enclosed.

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SKELETON OR ENCLOSED TYPE AS SHOWN
120 v. A.C. — 60 Cy. Approx. 1700 R. P. M.

Our new and improved 4-point bearing bracket makes our 4-pole shaded pole motor outstanding. Compare this motor with *any* other and see for yourself.

- **Absolutely uniform air gap of minimum width.**
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- **Priced competitively.**

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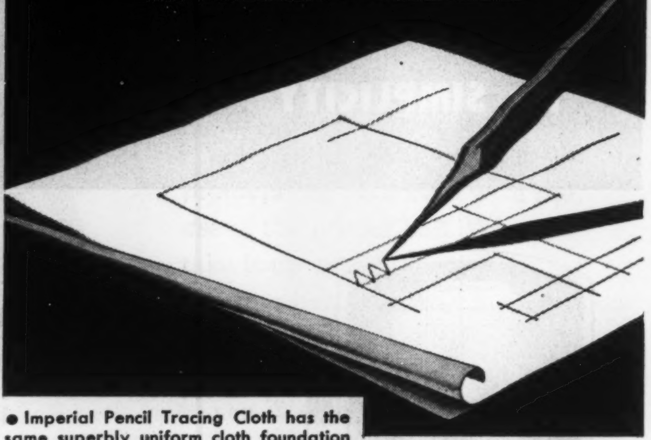

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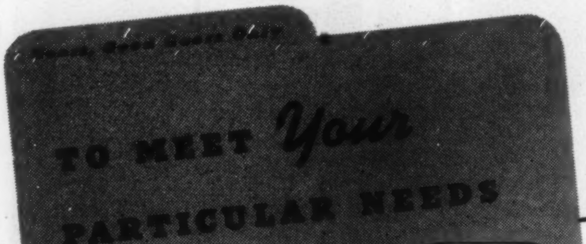

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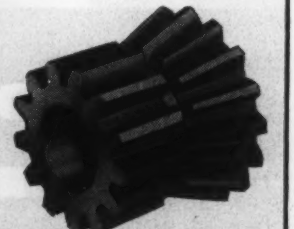

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These and hundreds of other fascinating new products are being made of Du Pont polythene . . . one of the most remarkable materials of modern chemistry.

Polythene molding powders are made in a wide range of colors by the Plastics Department of the Du Pont Company. Extruders, molders, and other processors convert the material into molded products, film, tubing, tape, filaments, etc.

In thin sections, polythene is tough and flexible. A new baby bottle made of polythene is soft, pliable, and strong. It needs no sterilizing. And it costs so little it *can be thrown away after use.*

In thick sections, such as pipe, polythene is relatively rigid. It resists most chemicals. As tubing it can be bent around corners, and rolled like a cable for easier handling.

During the war, polythene first came into use as an insulation material for high-frequency wire and coaxial cable. Since then it has found wide use in the electrical field. Current uses include jacketing for power cables and insulation for the coil in a new watt-hour meter.

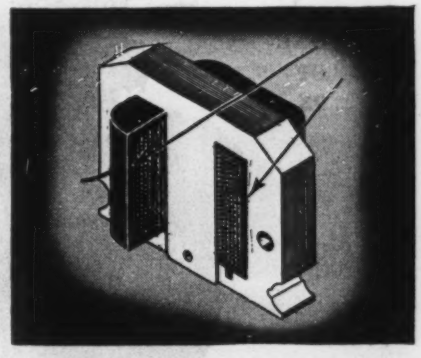
Polythene's unusual combination of properties is especially useful in the packaging field. It can be heat-sealed. It keeps out water, dust, and bacteria. And it stays tough and strong at low temperatures . . . is tasteless, odorless, and nontoxic. Items now packaged in polythene include foods, cosmetics, corrosive chemicals, and metal parts.

Manufacturers are making more and more new products of all types with DuPont polythene. For polythene offers so many advantages at low cost—including ease of molding, extrusion and machining.

The demand for polythene still exceeds the supply, but continuing increases in production are being pushed to catch up with demand. More information on uses and specific properties of polythene can be obtained from E. I. du Pont de Nemours & Co. (Inc.), Plastics Department, Empire State Building, 350 Fifth Avenue, New York 1, N. Y.; 7 South Dearborn Street, Chicago 3, Illinois; 845 East 60th Street, Los Angeles 1, California.

APRON, pitcher, tumblers, ice-cube tray, ice tub, bowls, sugar bowl, cream pitcher and tablecloth protector are all made of Du Pont polythene. Names of manufacturers of items shown above available on request.

SQUEEZABLE BOTTLES, blow molded from polythene, package products ranging from cosmetics to corrosive chemicals. (Deodorant bottle molded by Plax Corp., Hartford, Conn., for Jules Montenier, Inc., Chicago.)



POTENTIAL COIL for new watt-hour meter is insulated with Du Pont polythene for greater strength, reliability and secure positioning. (Watt-hour meter manufactured by General Electric Co., Schenectady, N. Y.)

DISPOSABLE BABY BOTTLE made from Du Pont polythene extruded as continuous, flat, sterile tubing; heat-sealed to form 4- or 8-oz. sections. (Made by Shellmar Products Corp., Mt. Vernon, Ohio.)

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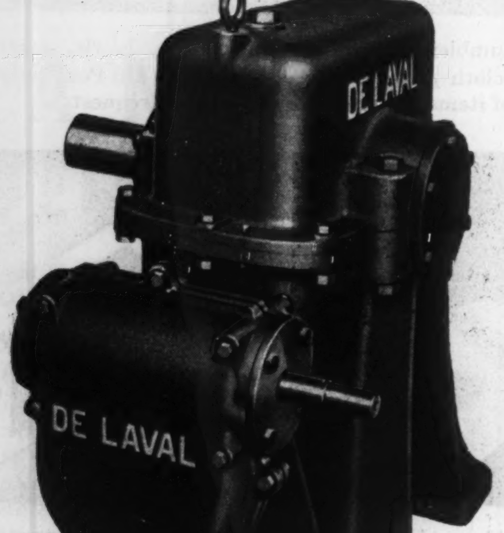
If your problem is to select a gear reducer capable of carrying high torques, consult De Laval, either directly or through a sales representative.



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✻ This double reduction De Laval Worm Gear Speed Reducer is available with many standard gear ratios and is but one of 93 sizes and types of standard De Laval Worm Gear Speed Reducers.

Worm Gear Division

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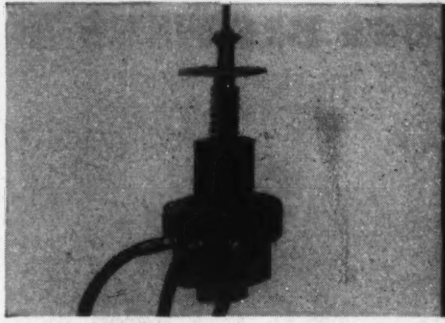
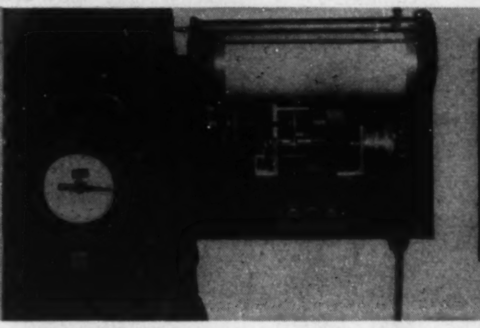
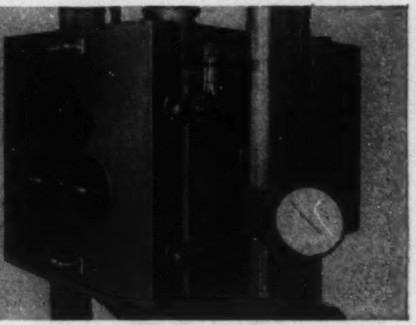
These accessories will broaden the usefulness—increase the value—of your present equipment



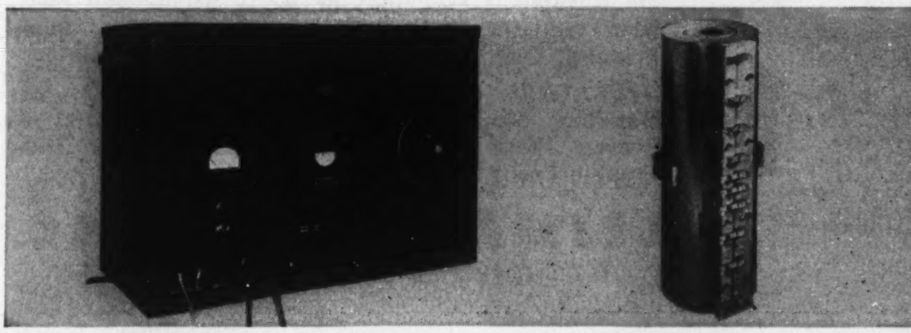


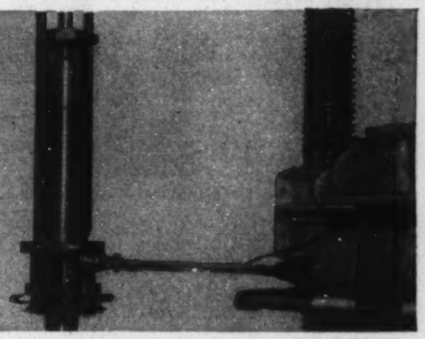


✓ Tate-Emery Air Cell extends precision range of testing machine downward to as little as 2 pounds, full scale. Portable or built-in indicator. Bulletin No. 264.

✓ Baldwin Strain Pacer permits maintenance of a constant rate of displacement between specimen gage points, rather than a constant rate of crosshead separation. Bulletin No. 289.

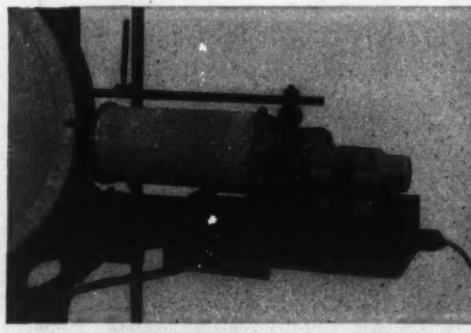
✓ Baldwin Controlled-Temperature Cabinet machine permits tension, compression and flexure tests at temperatures from —70° F to +200° F, maintained within ±1°. Bulletin No. 284.

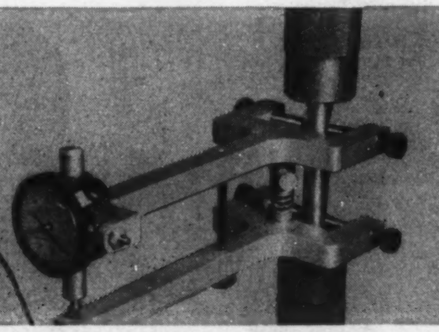


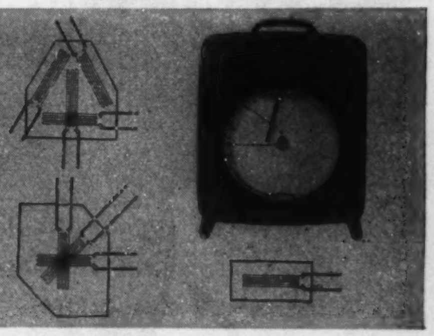


✓ Furnace and Control Panel for high-temperature testing, provide temperatures up to 1800°F (up to 2000°F on special order). Temperature uniformity up to ±3° is readily obtainable, and maintenance within 1° is not uncommon. Bulletin No. 261A.

✓ Baldwin PSH-8 extensometer (microformer model PSH-8M), for use with standard threaded-end specimens at temperatures up to 1600° F. Bulletin No. 262.







✓ Baldwin Stress-Strain Recorders. Models available for virtually all common makes of testing machines. Bulletin No. 262.

✓ H. F. Moore indicating extensometer accommodates round or flat specimens up to 8 inches in length. Bulletin No. 263.

✓ Baldwin *SR-4 Strain Gages and other associated equipment have become an invaluable tool in stress analysis.

**Trade-Mark Registered U. S. Pat. Off.*

These illustrations show only a few of the many Baldwin accessories that will implement existing machines for broader fields of use, and make them an even more valuable tool in scientific progress and industrial development. Some of these accessories can be used on any make of machine . . . others are limited to certain types. You will find complete information on each individual device in its special bulletins; the numbers are listed.

A new bulletin on grips and accessories—No. 261-A—is just off the press. It lists a number of the items illustrated, as well as others, and will be a helpful addition to your testing equipment file. We will be glad to send a copy on request.

The Baldwin Locomotive Works, Philadelphia 42, Pa., U.S.A. Offices: Boston, New York, Philadelphia, Houston, St. Louis, Chicago, Cleveland, Pittsburgh, San Francisco, Seattle, Washington. In Canada: Peacock Brothers, Ltd., Montreal, Quebec.

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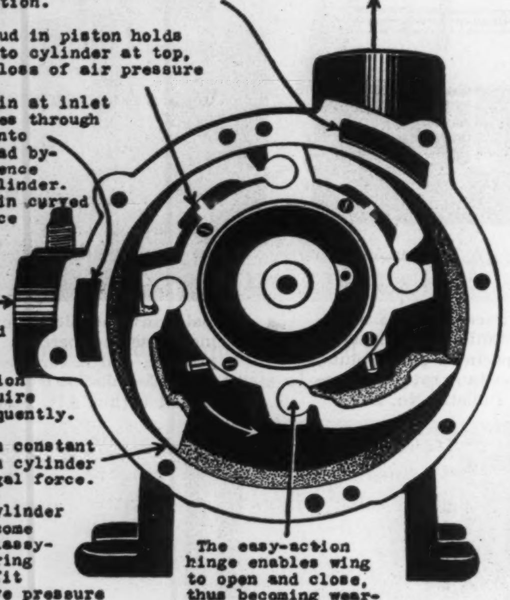


Air from cylinder through by-pass in cylinder head enters this slot on its way to the outlet above. No opening in curved inner surface of cylinder means quiet operation.

OUTLET threaded for iron pipe.

Enclosed stud in piston holds wing close to cylinder at top, preventing loss of air pressure or vacuum.

Air coming in at inlet at side comes through this slot into cylinder head by-pass and thence into the cylinder. No opening in curved inner surface of cylinder means quiet operation.

INLET threaded for standard iron pipe.

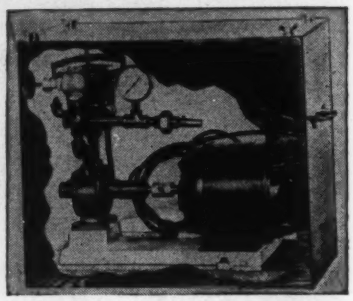
No composition tips to require renewal frequently.

Wing kept in constant contact with cylinder by centrifugal force.

Wing and cylinder surface become hard and glassy-like, insuring a perfect fit and positive pressure or vacuum.

Big air space resulting from small piston and curved wings.

The easy-action hinge enables wing to open and close, thus becoming wear-compensating by the action of centrifugal force.



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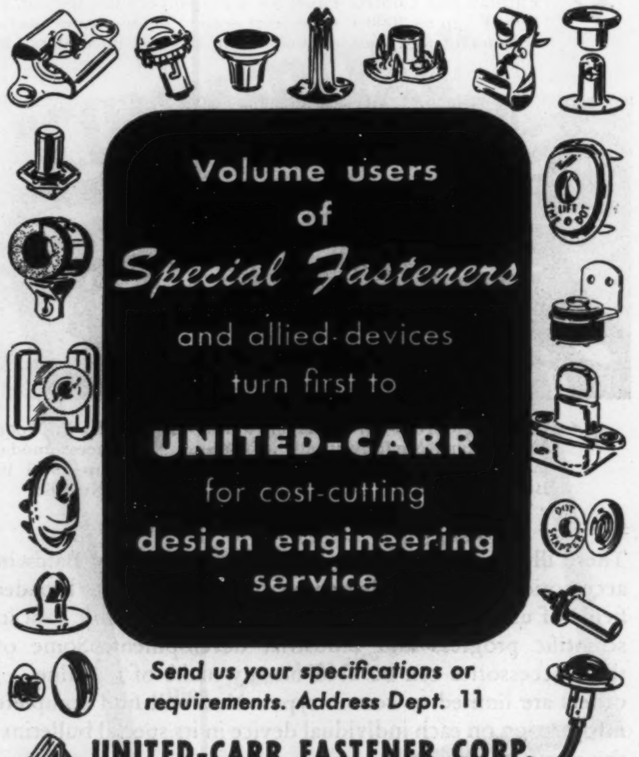

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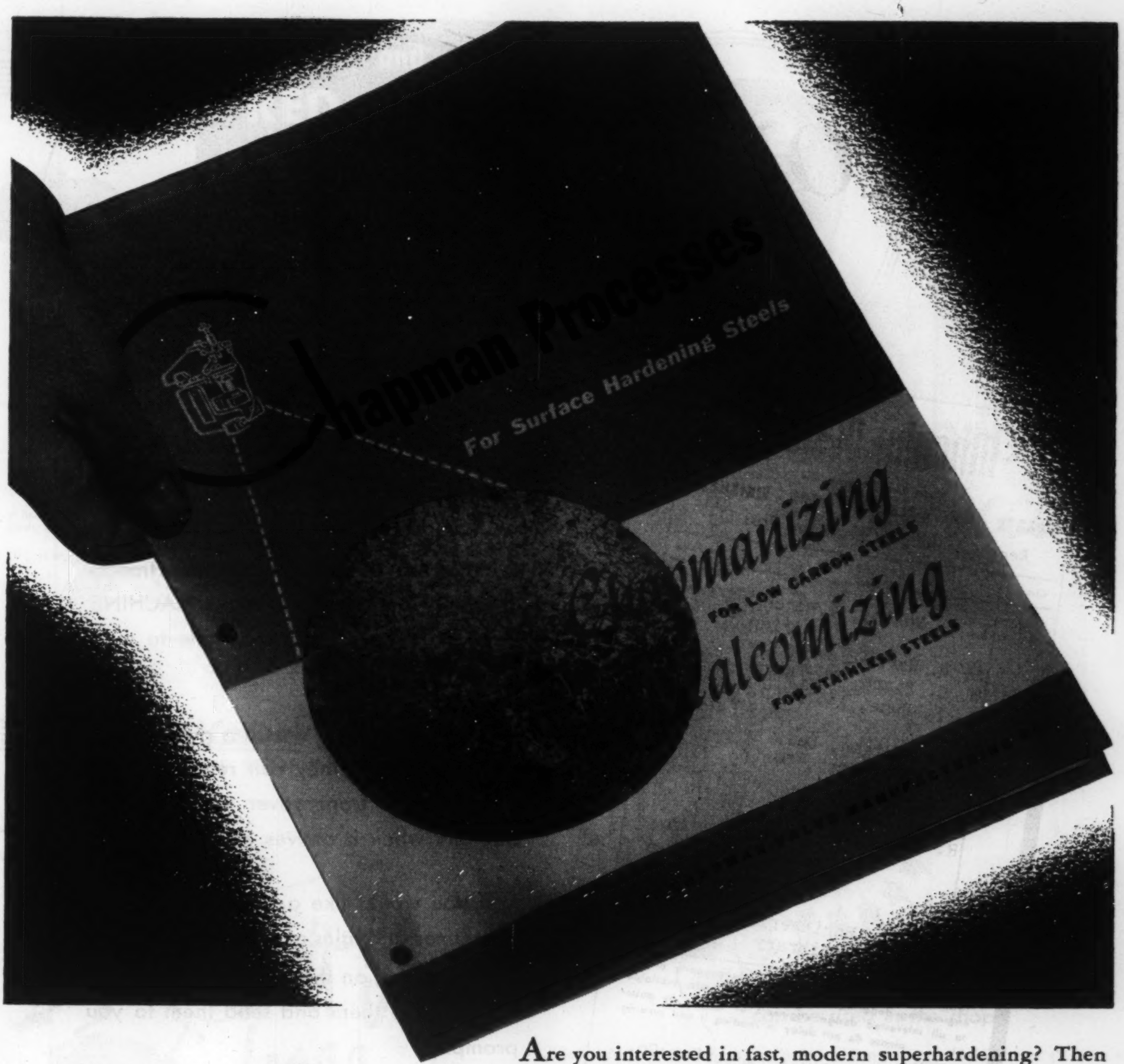
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For Surface Hardening Steels
Chapmanizing
FOR LOW CARBON STEELS
Malcomizing
FOR STAINLESS STEELS

How to Surface Harden in a Hurry!

Are you interested in fast, modern superhardening? Then send for this booklet today. In it are described two unique methods for surface hardening steels. Both are fast! Both are relatively inexpensive! Both will mean longer life . . . greater wear resistance . . . for your parts or products.

Chapmanizing is an unusually fast method for surface hardening low carbon steels. In only 1 to 4 hours it gives an alloy-like case from .002" to .035" deep — a case so tough and ductile it will not chip or check. The surface comes out silver-clean . . . ready for use with minimum finish-grinding.

Malcomizing gives stainless steels a wear and corrosion resistant surface with a hardness of approximately 1000 Vickers Brinell. Depth of case ranges from .005" to .015". Maximum hardness is slightly below the surface allowing for finish grinding and lapping.

It will pay you to investigate these two efficient surface hardening methods. Write today.

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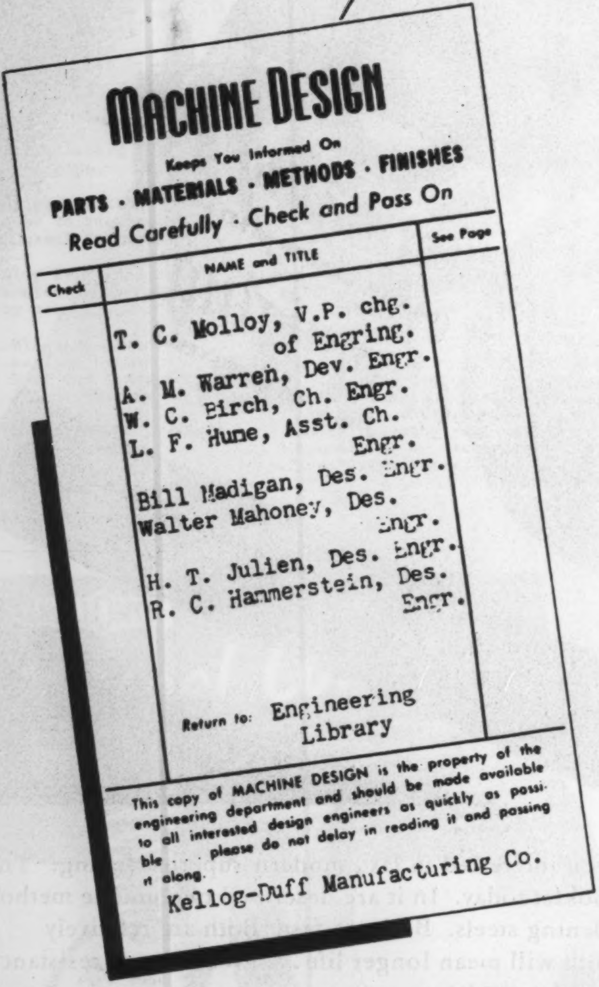

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	A. M. Warren, Dev. Engr.	
	W. C. Birch, Ch. Engr.	
	L. F. Hume, Asst. Ch. Engr.	
	Bill Madigan, Des. Engr.	
	Walter Mahoney, Des. Engr.	
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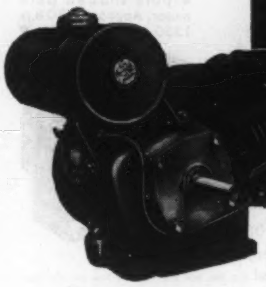

Let these $1\frac{1}{2}$ and 2 h. p. RED SEAL ENGINES

BUILD GOODWILL FOR YOU, TOO

Where height is critical, specify
AA-7
(1½ H.P. at 2600 r.p.m.)
or
AA-7B
(2 H.P. at 3200 r.p.m.)

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or
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Heavy-duty 6-to-1 reduction gear mounting in any of 4 positions, also available.

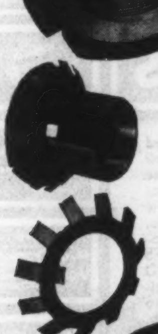
Compactness, balance, and extremely low center of gravity adapt these engines to an unusually broad range of applications, a range widened further by the fact that identical performance characteristics are available in models of differing profile and shape.

Torque substantially higher than in other engines of their ratings assures ample reserve power for suddenly-applied loads. These Red Seals cost less to run, and run longer without service, because their full rated horsepower is developed at moderate speed.

Let these products of Continental Motors, engine specialists for nearly half a century, help sell your product—help KEEP it sold. Installation drawings and full information on request.

Continental Motors Corporation
620 FORD BUILDING, DETROIT 26, MICHIGAN

Can't Shake Loose...



Standard's Locknuts and Lockwashers are made to stay . . . you can't shake them loose. They're easy to apply, durable, and can be used again and again. Order Standard Locknuts, Lockwashers, and Adapters for your application of ball and roller bearings . . . S.A.E. Standard, A.B.E.C. Standard, Heavy-duty and Specials.

Locknuts in sizes N-00 through AN-40 . . . Multi-prong Lockwashers in sizes W-00 through W-40 . . . Adapter sizes 7-9-11-13 for shaft sizes $1\frac{3}{16}$", $1\frac{7}{16}$", $1\frac{15}{16}$", $2\frac{3}{16}$" . . . standard shaft collars, sizes ½", ⅝", ¾", ⅞" and 1". Order now from our complete stock.

Standard
LOCKNUT & LOCKWASHER, INC.
118 W. ST. CLAIR ST., INDIANAPOLIS 4, INDIANA

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how LORD helps "TOCCO" stand the gaff

Now electronic induction heaters can be used in the shop.

Electronic tube induction heating long was confined to the laboratory because the electronic equipment just "couldn't stand the gaff" of shop usage.

After four years of intensive research and testing, The Ohio Crankshaft Company found the answer. The Toccotron 20 has proved a dependable shop tool for uniform, low cost production in numerous applications.

Four Lord Plate Form Mountings effectively isolate the Power Contactor Panel Assembly and protect the Toccotron from vibratory disturbances in the shop, regardless of their direction. Tube assemblies also are protected by Lord Mountings.

Whether you make electronic equipment or massive machinery—if your product is exposed to external vibration or if it has moving parts, a Lord Vibration Control System will increase its efficiency, durability and customer appeal. Consult a Lord engineer.

See our Bulletin in Sweet's 1949 File for Product Designers or write for Bulletin 900 today. It describes the complete line of Lord products and services.

LORD MANUFACTURING COMPANY, ERIE, PA.
Canadian Representative: Railway & Power Engineering Corp. Ltd.

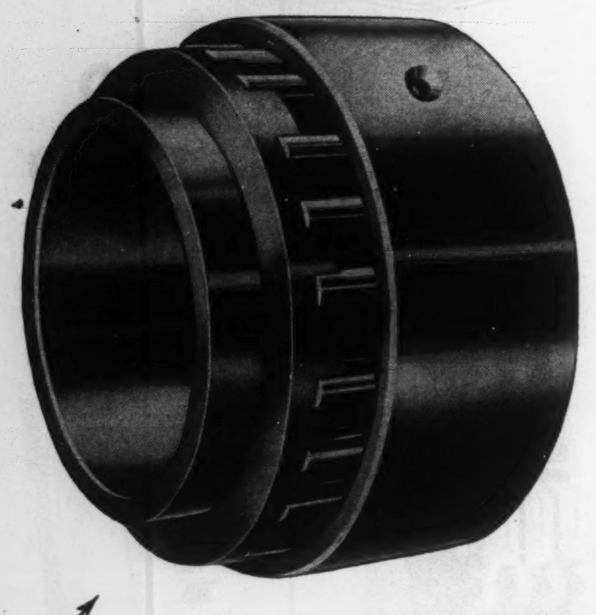
LORD Vibration Control Systems

Gluttons for punishment

American

Heavy-Duty

Roller Bearings



Designed especially for "tough going", AMERICANS have what it takes to render smooth, dependable service in heavy industrial applications. Strong, precision built, longer lasting, they will minimize your anti-friction bearing problems. Our technical staff will assist you in selecting the right bearings for your needs. Write.

AMERICAN ROLLER BEARING CO.

420 Melwood Street Pittsburgh, Pa.

Pacific Coast Office: 1718 S. Flower St., Los Angeles, Calif.

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alliance motors

for

Small Load Jobs!

Fans	**Toys**
Business Machines	**Vending Machines**
Controls	**Radio & television tuning**
Heating Appliances	
Turntables	**Other appliances**

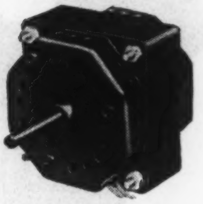
Mass production of small motors for *mass* markets at low cost—that's the job at Alliance!

Alliance motors rated from less than 1/400 h.p. on up to 1/25 h.p. are made semi-open, and fully enclosed. Some are uni-directional and others are reversible. Motors are designed for both continuous and intermittent duty loads. Covering a wide range of standard AC voltages and frequencies, Alliance offers motors of varied types with operating characteristics to fit the specific needs of small loads. Individual changes in design are available where quantity warrants.

Check these advantages!

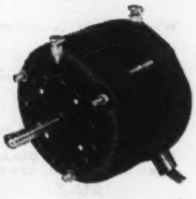
- **Low operating cost**
- **Low induced hum**
- **Low magnetic field**
- **Low first cost**
- **Cool running—quiet**
- **Flexible power range**
- **Slower controlled speeds**
- **Long life**

Write for catalog and specifications



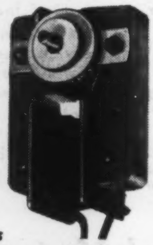
MODEL B

4-pole shaded pole motor. Approx. 1/30 h.p. 1550 r.p.m.



MODEL A

6-pole shaded pole motor. Approx. 1/30 h.p. 500 to 1050 r.p.m.



MODEL MS

2-pole shaded pole motor — full load h.p. .0021. Full load 2800 r.p.m.

ALLIANCE MANUFACTURING COMPANY • ALLIANCE, OHIO

Export Department: 401 Broadway, New York 13, N. Y., U. S. A.

ENGINEERED To The Job

- Learning Your Clutch Needs
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- Designing the Clutch
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- Engines and Marine Units
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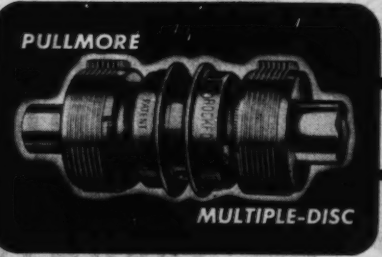

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A growing number of manufacturers depend on ROCKFORD for the solution of their CLUTCH problems because they appreciate our policy of working closely with their engineering departments in all phases of their power transmission and control developments. ROCKFORD cooperates with them to produce CLUTCHES and POWER TAKE-OFFS *that fit their specific needs.* ROCKFORD has the required CLUTCH experience, engineering skill and manufacturing facilities to make just the *right* application for each job. Send us a print showing *your* product's requirements for a ROCKFORD *engineered to the job* CLUTCH or POWER TAKE-OFF recommendation.

ROCKFORD CLUTCH DIVISION

BORG-WARNER

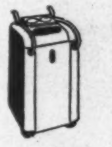
311 Catherine Street, Rockford, Illinois

Write for your copy of RBM

BULLETIN 200 on automotive electrical control devices for..

Passenger Cars

Trucks and Busses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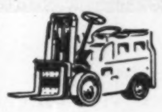
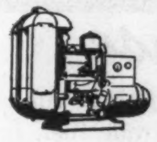
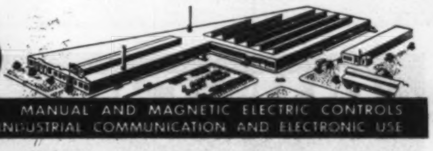

Industrial Electric Trucks


Gas Engine Auxiliaries

RBM



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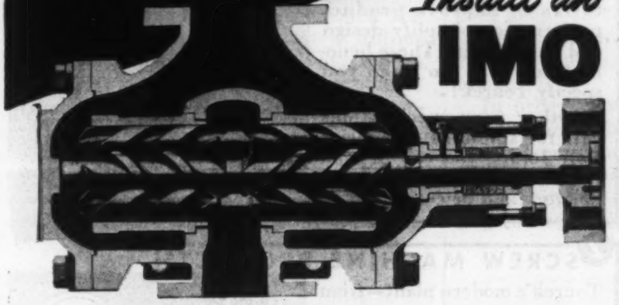
—FOR AUTOMOTIVE INDUSTRIAL COMMUNICATION AND ELECTRONIC USE

PULSATION A PROBLEM?

Install an **IMO**



With an IMO Pump delivery is not interrupted by the periodic strokes of a piston or the opening and closing of valves and ports. The turning of the rotors in an IMO forces the fluid from suction to discharge in a continuous, uniform flow.

IMO pumps can be furnished for practically any capacity and pressure required for oil, hydraulic-control fluids and other liquids.

Send for Bulletin I-145-D.

IMO means I MOVE OIL

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TRENTON 2, NEW JERSEY

THIS TRUCK ELIMINATED 28 POUNDS of DEADWEIGHT

By USING This MECHANICS 34% LIGHTER JOINT

Not much, you may think. But, if you consider that those 28 pounds of DEADWEIGHT might have been carried 300,000—400,000 or 500,000 miles *needlessly*, QUITE A LOT! Why make *your* trucks haul unnecessary, non-profit-earning DEADWEIGHT that reduces the PAYLOAD part of their legal gross poundage? MECHANICS Roller Bearing UNIVERSAL JOINTS Truck PROPELLER SHAFTS are made 34% lighter, run smoother and place much less load on transmission and pinion bearings — without loss of torque. Let our engineers help add to the ton-mile capacity of *your* trucks by specifying weight-saving MECHANICS Roller Bearing UNIVERSAL JOINTS Truck PROPELLER SHAFT applications.

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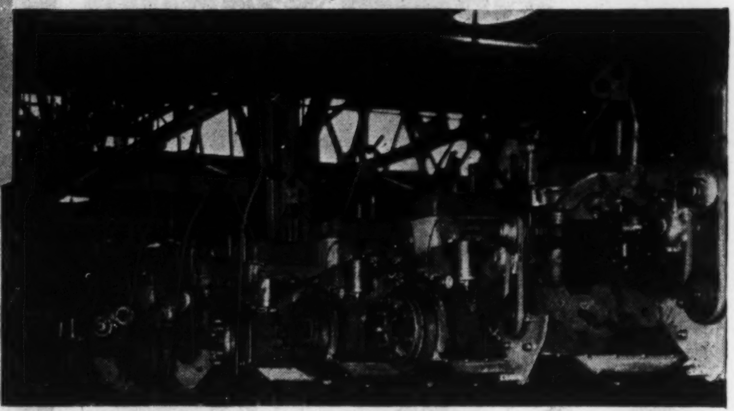
For Cars · Trucks · Busses and Industrial Equipment

RUGGED A-C ENGINES *Cost less*

Mass Production makes Allis-Chalmers Power Units cost less to buy and to service.



-to own

—because they are *mass produced* along with engines by the thousands for tough tractor service. Users benefit from these savings, as well as interchangeability of parts and other advantages of mass production.

There are further savings in getting *exactly* the power needed. Any power requirement can be filled economically with the five sizes of A-C Power Units—15 to 110 b. hp. They can be used singly or two or more together.

-to use

A-C Power Units run inexpensively on gasoline, low-grade fuel, natural gas or butane. Their "tractor service" stamina keeps them on the job during critical work periods—avoids loss of valuable time due to shutdowns, helps build product acceptance and good will. Service facilities are nation-wide.

Get all the facts on rugged, high-torque A-C Engines for dependable, *low-cost* power. Our power engineers will gladly help select the correct unit for your needs.

ALLIS-CHALMERS
TRACTOR DIVISION — MILWAUKEE 1, U. S. A.

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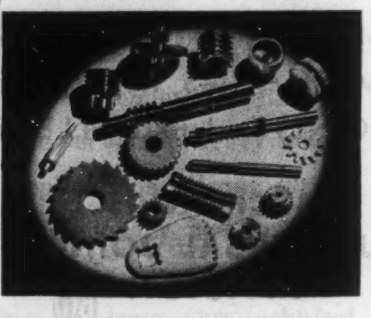
a little "*pitch*" talk about *Abart* gears



But not the type from the man in the loud checked suit. Rather, something about diametrical pitch—at which, ABART is a specialist. Each type of gear in the ranges listed below is custom-cut to your specifications. No stocks. Precision made and long lasting. Fabricated from any metallic or non-metallic material. Immediate attention on your order, whether it's large or small.

SPUR—96 D.P. to 5/7 D.P. ¼" P.D. to 18" P.D.

BEVEL—48 D.P. to 5/7 D.P. Max. P.D. 6¼"—max. ratio 4:1.

WORMS—32 D.P. to 5/7 D.P. ½" P.D. to 5" P.D.

WORM WHEELS—32 D.P. to 5/7 D.P. 1" P.D. to 14" P.D.

HELICAL & SPIRAL—96 D.P. to 6 D.P. up to 14" P.D.

SPROCKETS—1¼" dia. to 14" dia.

NO STOCK GEARS—NO GEAR CATALOG

SEND B/P, SAMPLE OR SPECIFICATIONS TODAY FOR PROMPT QUOTATION.

ABART GEAR & MACHINE CO.

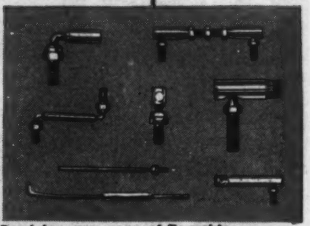
4821 W. 16th ST. CHICAGO 50, ILL.

TOUREK BALL JOINTS and SCREW MACHINE PRODUCTS

① BALL JOINTS

The use of Tourek Ball Joints has helped many manufacturers to improve product performance, simplify design and reduce costs. These benefits are yours too when you specify Tourek!.

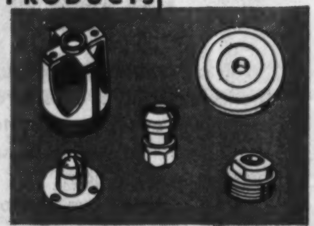
Whether your specifications call for standard or special Ball Joints, you can depend upon Tourek performance, delivery and prices!



Send for your copy of Tourek's 16-page Ball Joint Catalog. It fully describes 12 standard types in 54 sizes (carried in stock), and has data on special types as well.

② SCREW MACHINE PRODUCTS

Tourek's modern plant—from the tool room to the batteries of giant 6-spindle automatics —is geared to turn out your screw machine product needs in any size up to 2⅝", from any type of metal. Twenty-eight years of production experience back up every job which Tourek undertakes.



For prompt quotation on your screw machine products requirements, simply send blueprint or sample.

J. J. TOUREK MFG. CO.
4701 W. 16th St., Chicago 50, Ill.

MAKERS OF QUALITY SCREW MACHINE PRODUCTS

ESTABLISHED 1920
TOUREK
FAMOUS BALL JOINTS

West's Culture Assailed As Soviet Schools Open

LONDON, Sept. 1—A new school year began in Russia today and Pravda, the Communist party newspaper, exhorted teachers to fill their students with "profound contempt for bowing and scraping before the bourgeois culture of the West."

Dear Soviet Teachers:

We note that you have been discreetly silent on some aspects of the Communist system. And that you have been urged by Pravda to fill your students with "profound contempt" for the admiration given to ours.

May we respectfully suggest a few more things that you'd better keep quiet about if you want the young Russians to grow up convinced Communists.

Don't tell them that in America the opportunity for advancement is unlimited—that here a man can work where he pleases and change his job when he pleases, and that he has the right to organize and bargain collectively.

Don't say anything about the competitive system, with rewards for initiative and enterprise in free markets—the same system which has produced a standard of living about ten times higher than yours.

Don't mention that here people can own things and manage their own businesses . . . and invest money in new undertakings.

Don't breathe a word about the American urge to invent better machines—and more productive ways to use them.

Don't refer to a dynamic way of life that keeps on turning out more and better goods—keeps on lowering costs and raising wages, with shorter working hours.

In other words, don't give them any of the facts about what happens when free people, governing themselves and spurred by ambition, go all-out to build a new kind of country—different from any the world has ever seen.

We don't say our way is perfect—far from it. We still have our ups and downs of prices and jobs. But we *know* what's wrong and we're free to *do* something about it. Change is our middle name. *And in the long run, our system always changes for the better.*

P.S. About that "priority of inventions," the point isn't whether the Russian scientist Lodygin invented electric light before Edison, but what happened *after* it was invented. Which system—yours or ours—has mass-produced for more people the daily benefits of such inventions as the automobile, telephone, radio, refrigeration, central heating, modern plumbing and better farm machinery? The world knows that it is *our* system!

John Q. Public, U.S.A.

THE BETTER WE PRODUCE, THE BETTER WE LIVE

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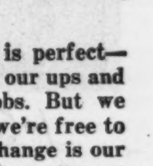
MACHINE DESIGN

FREE! Send for this valuable booklet today:

In words and pictures, it tells you
- How our U. S. Economic System started
- Why Americans enjoy the world's highest standard of living
- Why we take progress for granted
- How mass production began
- How we have been able to raise wages and shorten working hours
- Why more Americans have jobs than ever before
- Why the mainspring of our system is productivity
- How a still better living can be had for all



MAIL THE COUPON to Public Policy Committee, The Advertising Council, Inc., 25 West 45th St., New York 19, N. Y.

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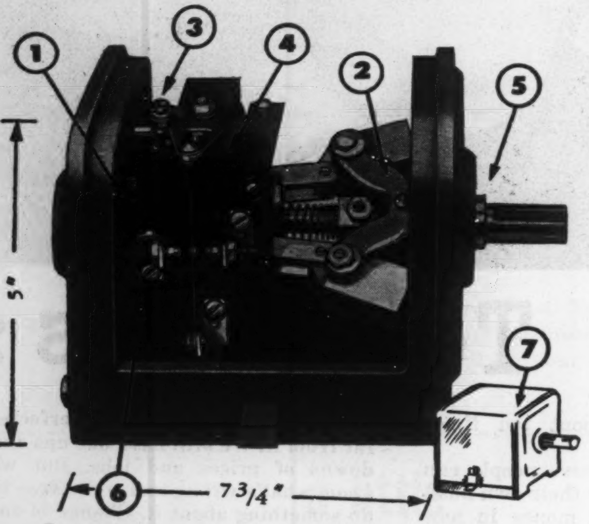
7 REASONS WHY EUCLID Centrifugal Switches are your answer

. . . for plugging, overspeed or underspeed protection, non-plugging and motion interlocking:



1. **Available with any standard contact arrangement. Illustrated above is a two-circuit switch with normally open SPDT contacts.**
2. **Operating range for contacts to open or close runs from a minimum of 125 rpm to 2530 rpm. Safe maximum speed . . . 3600 rpm.**
3. **Ball-bearing engaging contact-making arm minimizes friction to assure trouble-free operation.**
4. **Contact-arm stops prevent undue wear of contacts.**
5. **Sealed and permanently lubricated precision ball bearings eliminate bearing maintenance.**
6. **Silver-to-silver contacts assure long life. When necessary, they are easily replaced. Snap-action contacts to assure quick make-and-break are available.**
7. **Available in dust-tight and oil-resistant enclosures for surface or flange mounting; and also in permissible enclosures for hazardous locations.**

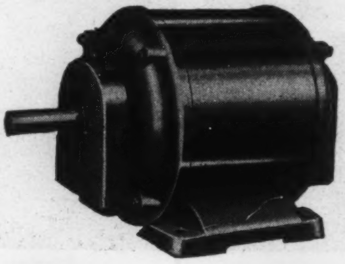
Twenty-seven years of control application and manufacturing experience back this Euclid Electric & Manufacturing Centrifugal Switch which is finding wider and wider application on machine tools to increase production; on hazardous industrial machinery to increase safety; and for motion interlocking.

Ask your Euclid Electric & Manufacturing Co. Representative for complete information or write directly to us.

EE The Euclid Electric & Mfg. Co.
MADISON, OHIO

This MOTOR *comes from a large Family!*

VALLEY Ball Bearing Motors are built in sizes from ½ hp up to 75 hp, providing wide adaptability in power planning. VALLEY'S cool running splash proof, dust proof construction insures long hours of dependable power under the most hazardous conditions.



You'll find the type of Motor you need in your power planning when you investigate VALLEY MOTORS.

Valley
VALLEY
ELECTRIC CORPORATION
4221 FOREST PARK BLVD. • ST. LOUIS 8, MO.

Solenoid STAINLESS STEEL *Valves*

SKINNER ELECTRIC VALVES

ACTUAL SIZE

- ★ Standard pressure range, 5 to 250 psi
- ★ Dimensions 2¾" high x 1⅝" dia.
- ★ Impregnated coils withstand moisture and condensation
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- ★ Power consumption 10 watts max.
- ★ Pipe connections to specification
- ★ Also many special valves for handling pressures from 5 to 850 psi

THREE WAY - TWO POSITION
TWO WAY - NORMALLY CLOSED
TWO WAY - NORMALLY OPEN

Skinner will be pleased to make recommendations on your particular design applications — they have for hundreds of others. Write today for details and catalog.

SKINNER ELECTRIC VALVES
***Skinner* ELECTRIC VALVE DIV.**
THE SKINNER CHUCK COMPANY
133 Belden Ave., Norwalk, Conn.

Fast, Safe, Adaptable

... the An-cor-lox lock nut

1. Spins on fast by hand. One piece. All metal. Available in high, standard, thin and acorn or cap designs.

2. Tightens just like an ordinary nut. Ideal for primary setup. Locking ring at base of nut; no extra stud length required.

3. Ring grips bolt with vibration and shock-proof grip. No axial play. Standard wrenches. Re-usable many times.

4. When backed off, locking ring stays locked! Prevents "walking off" even if other parts of assembly loosen.

Don't select your lock nut until you've tested An-cor-lox. Send today for descriptive literature and free standard samples.

An-cor-lox
TRADE MARK REGISTERED
Lock Nuts

LAMINATED SHIM CO., Inc., *An-cor-lox Division,* **1205 Union St., Glenbrook, Conn.**
AN-COR-LOX NUTS • SHIMS • SHIM STOCK • STAMPINGS

PUT A MERCURY CLUTCH ON THE JOB

for
EASY STARTING
EFFICIENT OPERATION
SMOOTH ACCELERATION
of
ELECTRIC MOTORS

MERCURY CLUTCH

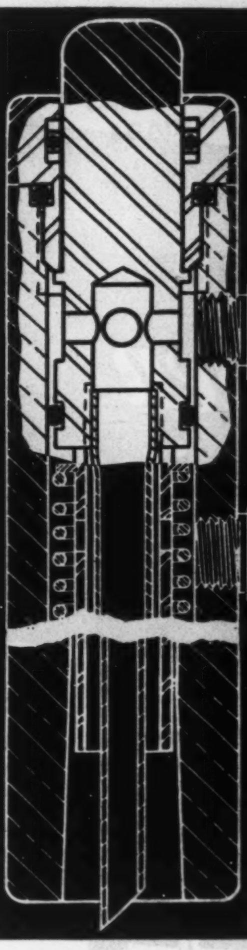
A Mercury Clutch will reduce starting current demands and provide positive protection against motor damage, blown fuses, and resulting fire hazards due to extreme low voltage conditions. Write for catalog.

also for
GASOLINE ENGINES

MERCURY CLUTCH

On a gasoline engine a Mercury Clutch allows load-free starting and no-load idling. It eliminates stalling. Write for catalog.

Mercury Clutch Division
AUTOMATIC STEEL PRODUCTS INC • CANTON 6 • OHIO



LINEAR
"O" Rings
Solved
Another Leakage Problem!

The Linear "O" rings used in the P. R. Mallory Resistance Welding Electrode Holder make it completely leakproof. They prevent cooling water from dropping on the material being welded, where it could cause rust and discoloration on the finished product.

Previous holders used a packing which tended to dry out when not in use . . . when dry, it compressed to a point where it would not make a perfect seal. Linear "O" rings solved this difficult problem . . . they retain their size and shape making a perfect seal when the holders are in use —or idle.

In addition to a long list of natural or synthetic rubber compounds adaptable to a wide range of temperatures, gases and liquids, Linear is successfully moulding "O," "V," "U" or other shapes of Kel-F, Teflon and Silicone for special applications. These materials are suitable for seals from minus 320°F. to plus 350°F. against concentrated sulfuric, hydrofluoric, hydrochloric and other vigorous oxidizing materials.

For your individual packing design or application, CALL LINEAR.

"PERFECTLY ENGINEERED PACKINGS"
LINEAR
LINEAR, Inc., STATE ROAD & LEVICK ST., PHILADELPHIA 35, PA

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Salesmen of Security

The executives of the more than 20,000 companies that have sponsored the Payroll Savings Plan

The 7,500,000 workers who are each investing on the average of $20 per month in Savings Bonds

The employees who serve as volunteers selling U. S. Savings Bonds to their fellow employees

Here's a sales force that's helping to win economic peace of mind for the nation. It already has dealt heavy blows to inflation, fear, and doubt. *This sales force is comprised of people who really are doing something to build security and protect the American way of life.*

They are building security for themselves by buying Bonds. Every $3 they invest will pay $4 at maturity.

They are building security for their companies. As each Bondholder's own sense of security increases with his Bond purchases, he becomes a better worker. Plant morale improves. Production increases. Absenteeism, labor turnover, and the accident rate all decline. Concurrently relations between employer and employee improve.

They are building security for the nation. Savings Bond dollars are deferred purchasing power—an assurance of good business to come. The Treasury uses net Savings Bond dollars to fight inflationary credit potential in the banking system by retiring short-term bank-held Federal securities.

If your company isn't an active part of this sales force, better join now and get in on the benefits! Full information is available from your State Director, Savings Bonds Division, U. S. Treasury Department. Phone him or write the Treasury Department, Washington 25, D. C.

The Treasury Department acknowledges with appreciation the publication of this message by

MACHINE DESIGN

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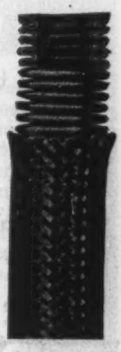

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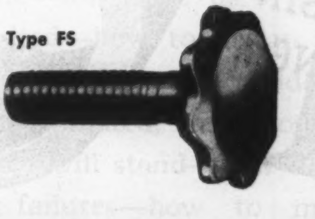

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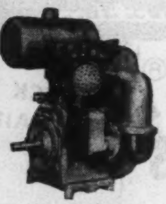
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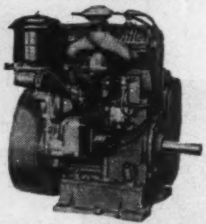
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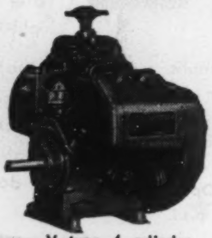
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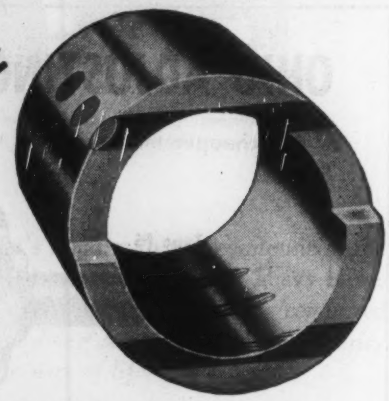

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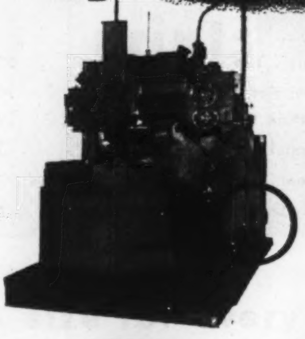

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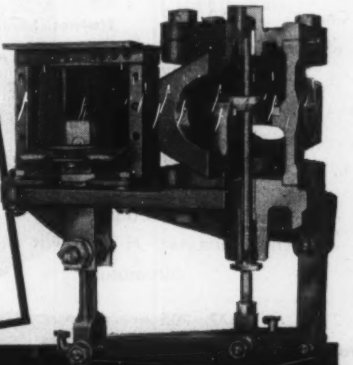

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ADVERTISING INDEX

A

Abart Gear & Machine Co. 260
Acme Industrial Co. 252
Alemite, Division of Stewart Warner Corp. 171
Allegheny Ludlum Steel Corp. 245
Allen Manufacturing Co. 192
Alliance Manufacturing Co. 258
Allis-Chalmers . . Inside Front Cover, 50, 51, 260
Allis-Chalmers, Tractor Division 260
Aluminum Company of America 8
American Brass Co., The, American Metal Hose Branch 241
American Felt Co. 209
American Hard Rubber Co. 198
American Metal Hose Branch, The American Brass Co. 241
American Nickeloid Co. 165
American Roller Bearing Co. 258
American Screw Co. 272
American Steel & Wire Co. 34, 35
Amgears, Inc. 218
Arkwright Finishing Co. 172
Armstrong Cork Co. 227
Arrow-Hart & Hegeman Electric Co., The . 27
Atlantic Metal Hose Co., Inc. 265
Automatic Steel Products, Inc., Mercury Clutch Division 263

B

Baldwin-Duckworth Division of Chain Belt Co. 14, 15
Baldwin Locomotive Works, The 253
Barnes, Wallace, Co. 73
Bellows Co., The 212
Berry Motors, Inc. 195
Beryllium Corp., The 210
Bethlehem Steel Co. 20
Blackhawk Manufacturing Co. 22, 23
Bodine Electric Co. 1
Brandt, Charles T., Inc. 10
Briggs & Stratton Corp. 200
Brown & Sharpe Manufacturing Co. 173
Browning Manufacturing Co. 242
Bruning, Charles, Co., Inc. 269
Brush Development Co., The 184
Bundy Tubing Co. 197
Bunting Brass & Bronze Co., The 39

C

Cambridge Wire Cloth Co. 180
Carnegie-Illinois Steel Corp. 34, 35
Carpenter Steel Co., The 236
Cash, A. W. Valve Manufacturing Corp. . 248
Chapman Valve Manufacturing Co., The . 255
Chicago Metal Hose Corp. 12
Chicago Rawhide Manufacturing Co. . .2, 161
Cincinnati Gear Co., The 250
Columbia Steel Co. 34, 35
Commercial Shearing & Stamping Co., The 252
Continental-Diamond Fibre Co. 239
Continental Motors Corp. 257
Cramer, R. W., Co., Inc., The 182
Crane Co. 74
Crocker-Wheeler Electric Manufacturing Co. 40, 41
Cullman Wheel Co. 244
Cutler-Hammer, Inc. ....Back Cover

D

Dayton Rubber Co., The 235
De Laval Steam Turbine Co. 252, 259
Delco Products, Division of General Motors Corp. 237
Diamond Chain Co., Inc. 193
Dow Corning Corp. 176
du Pont de Nemours, E. I., & Co., Inc. . . 251

E

Eastman Kodak Co. 177, 205
Elastic Stop Nut Corporation of America 221
Electrical Engineering and Manufacturing Corp. 55
Electric Auto-Lite Co., The 86
Electric Motor Corp. 242
Electro Dynamic, Division of the Electric Boat Co. 42
Electrol, Inc. 208
Elliott Manufacturing Co. 220
Euclid Electric & Manufacturing Co., The . 262
Ex-Cell-O Corp. 48

F

Fafnir Bearing Co., The 37
Farval Corp., The 232
Fasco Industries, Inc. 204
Fawick Airflex Co., Inc. 185
Federal-Mogul Corp. 28
Fellows Gear Shaper Co., The 72
Foote Bros. Gear and Machine Corp. 67

G

Gates Rubber Co., The 36
Gear Specialties 13
General American Transportation Corp. . 29
General Electric Co. . .24, 25, 59, 63, 218, 244
General Plate Division of Metals and Controls Corp. 43
Gerotor May Corp. 75
Gisholt Machine Co. 201
Globe Steel Tubes Co 228
Graver Tank & Manufacturing Co., Inc. . . 18
Gray Iron Founders' Society, Inc. 68

H

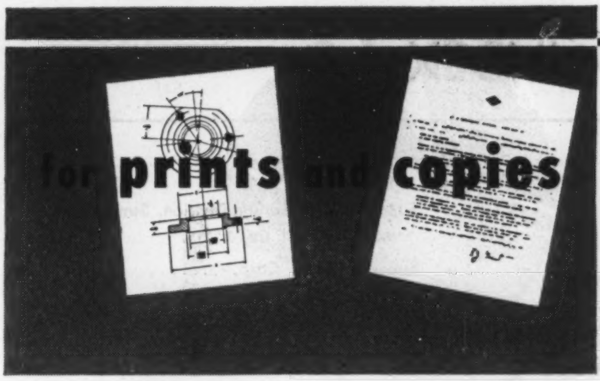
Hanna Engineering Works 191
Hannifin Corp. 246
Haynes Stellite Co. 65
Hercules Powder Co. 163
Hoover Ball and Bearing Co. 206
Houghton, E. F., & Co. 57
Hunt, C. B., & Son, Inc. 196
Hyatt Bearings Division, General Motors Corp. 187
Hydraulic Equipment Co. 52

I

Imperial Pencil Tracing Cloth Co. 250
Indiana Gear Works 188
Indiana Steel Products Co., The 70
International Nickel Co., Inc., The 4

J

Jenkins Bros. 203
Johns-Manville 76
Johnson Bronze Co. 159
Johnson, Carlyle, Machine Co., The 83
Johnson Corp., The 267
Jones & Laughlin Steel Corp. 222, 223
Jones, Howard B., Division, Cinch Manufacturing Corp. 266



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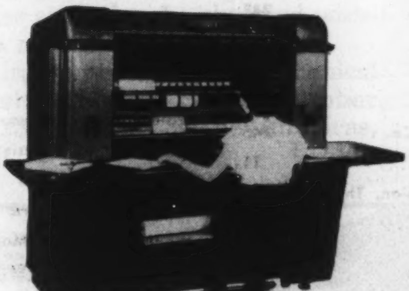

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ADVERTISING INDEX

K

Kohler Co. 230

L

Laminated Shim Co., Inc., An-cor-lox Division 263
Leiman Bros., Inc. 254
Lincoln Electric Co., The 181
Linear, Inc. 263
Link-Belt Co. 5
Logansport Machine Co., Inc. 265
Lord Manufacturing Co. 257

Mc

McGill Manufacturing Co., Inc. 62

M

Mahon, R. C., Co., The 207
Master Electric Co., The .... Inside Back Cover
Mechanics Universal Joint Division, Borg-Warner Corp. 259
Meehanite Metal Corp. 215
Mercury Clutch Division, Automatic Steel Products, Inc. 263
Miniature Precision Bearings, Inc. 266
Minnesota Mining & Manufacturing Co. 202
Mitchell-Bradford Chemical Co. 220
Moccasin Bushing Co. 266
Morse Chain Co. 49

N

National Acme Co., The 54
National Broach and Machine Co. 58
National Forge and Ordnance Co. 199
National Formetal Co., Inc. 21
National Motor Bearing Co., Inc. 47
National Vulcanized Fibre Co. 178
New Departure, Division of General Motors Corp. 6
New Jersey Zinc Co., The 219
Norma-Hoffmann Bearings Corp. 30, 31

O

Ohio Nut & Bolt Co., The 265
Oilgear Company, The 9
Ozalid, Division of General Aniline & Film Corp. 224

P

Packard Electric Division, General Motors Corp. 211
Parker-Kalon Corp. 17, 19
Pesco Products Division, Borg-Warner Corp. 16
Plastic and Rubber Products, Inc. 249
Pope Machinery Corp. 217
Post, Frederick, Co., The 233

R

Racine Tool and Machine Co. 234
Rapidesign, Inc. 246
Raybestos-Manhattan, Inc., Equipment Sales Division 189
R-B-M Division, Essex Wire Corp. 259
Redmond Co., Inc. 78
Reliable Spring & Wire Forms Co., The 242
Republic Steel Corp. 46
Resistoflex Corp. 186
Revere Copper and Brass, Inc. 226
Richardson Co., The 80
Robbins & Myers, Inc. 213
Rockford Clutch Division, Borg-Warner Corp. 258
Rotary Seal Co., The 169
Ruthman Machinery Co., The 267

S

Scintilla Magneto Division of Bendix Aviation Corp. 229
Scott, Hermon Hosmer, Inc. 248
Scovill Manufacturing Co. 66
Scruggs, Loyd, Co., The 250
Shakeproof, Inc. 33
Sier-Bath Gear and Pump Co. 246
SKF Industries, Inc. 11
Skinner Electric Valve Division, The Skinner Chuck Co. 262
Smith, A. O., Corp. 240
Smith, Winfield H., Corp. 190
Speer Carbon Co. 247
Spencer Thermostat Division, Metals and Controls Corp. 38
Stalwart Rubber Co. 79
Standard Locknut & Lockwasher, Inc. 257
Standard Pressed Steel Co. 243, 254
Stephens-Adamson Manufacturing Co. 194
Strom Steel Ball Co. 248
Sundstrand Hydraulic Division, Sundstrand Machine Tool Co. 82
Superior Steel Corp. 53

T

Telechron, Inc. 238
Tennessee Coal, Iron & Railroad Co. 34, 35
Timken Roller Bearing Co., The 179
Titeflex, Inc. 216
Torrington Co., The 231
Tourek, J. J., Manufacturing Co. 260
Townsend Co. 77
Twin Disc Clutch Co. 85

U

Union Carbide and Carbon Corp. 65
United-Carr Fastener Corp. 254
United States Rubber Co. 271
United States Graphite Co., The 44, 45, 71
United States Steel Corporation Subsidiaries 34, 35
United States Steel Export Co. 34, 35
United States Steel Supply Co. 34, 35

V

Valley Electric Corp. 262
Veeder-Root, Inc. 60
Vickers, Inc. 69
Victor Manufacturing & Gasket Co. 26
Viking Pump Co. 244

W

Waldes Kohinoor, Inc. 225
Ward Leonard Electric Co. 174, 175
Western Felt Works 32
Westinghouse Electric Corp. 64, 183
Whitney Chain & Manufacturing Co., Division of Whitney-Hanson Industries, Inc. 81
Wisconsin Motor Corp. 266
Worthington Pump and Machinery Corp. 61

Z

Zenith Carburetor Division of Bendix Aviation Corp. 56

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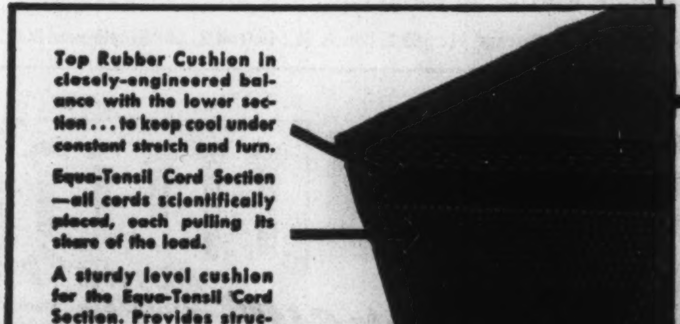
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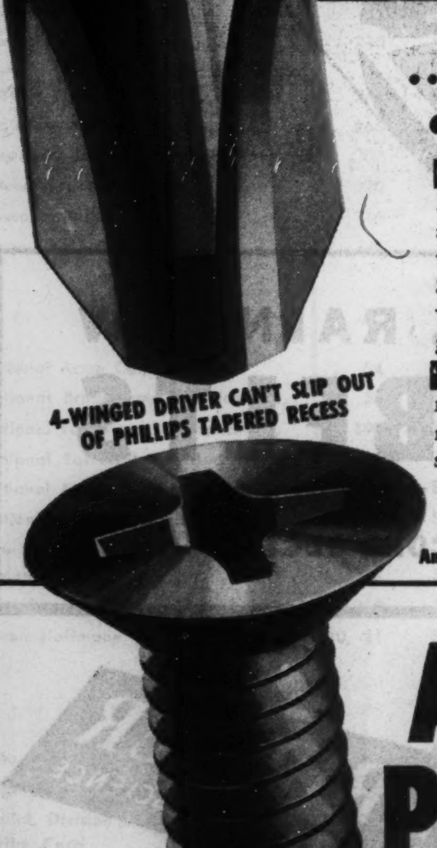

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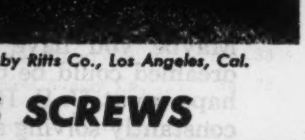

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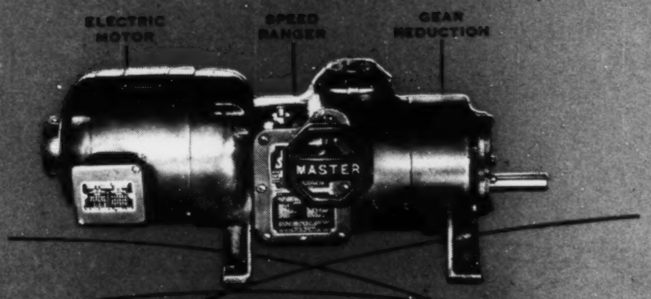

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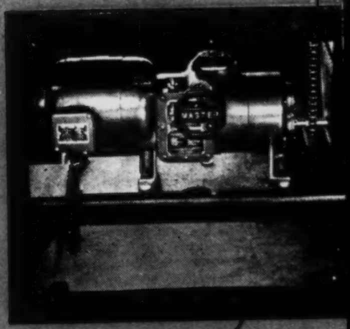

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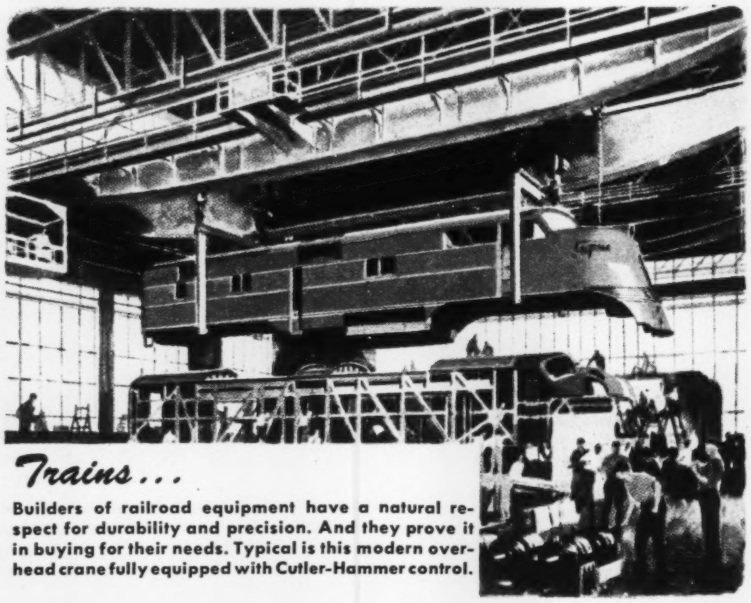
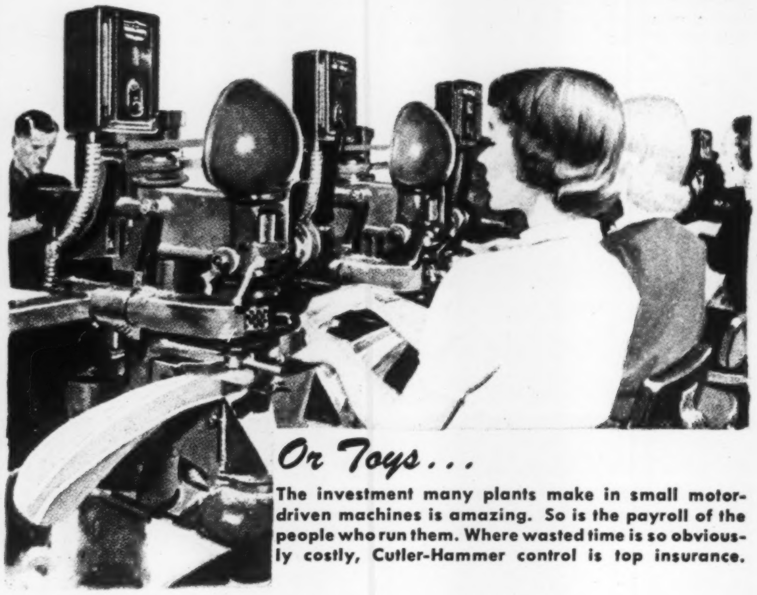
Tankers . . .

Back and forth, up and down, 'round and 'round, every motion of this giant shipyard crane must be under precise and dependable control. The safety and efficiency of many workers insist on Cutler-Hammer.



Trains . . .

Builders of railroad equipment have a natural respect for durability and precision. And they prove it in buying for their needs. Typical is this modern overhead crane fully equipped with Cutler-Hammer control.



Or Toys . . .

The investment many plants make in small motor-driven machines is amazing. So is the payroll of the people who run them. Where wasted time is so obviously costly, Cutler-Hammer control is top insurance.

Manufacturing *anything* today is a problem in teamwork . . . teamwork between men, motors, and machines. Men are employed for their intelligence. Machines provide the facility for applying judgment and skill. Electric motors supply the brute force. And motor control is the connecting link that permits all these elements to work together as one.

Here is the reason experienced engineers and production men grant motor control an importance far greater than either its relative physical size or cost might suggest to the casual observer. It is not only a vital factor in the efficient use of men, motors, and machines but the ever-watchful guardian of their safety. Its easily reached push buttons or automatic functions avoid both wasted steps and possible hazards. Its overload devices protect equipment from damage; production schedules from those intolerably costly interruptions.

No matter what *you* make, you too will find it pays to insist on Cutler-Hammer Motor Control for *dependable* performance. CUTLER-HAMMER, Inc., 1310 St. Paul Ave., Milwaukee 1, Wis. *Associate:* Canadian Cutler-Hammer, Ltd., Toronto.

Cutler-Hammer general purpose motor control is recommended by a majority of all electric motor manufacturers, is featured as standard equipment by machinery builders, is carried in stock by recognized electrical wholesalers everywhere.

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